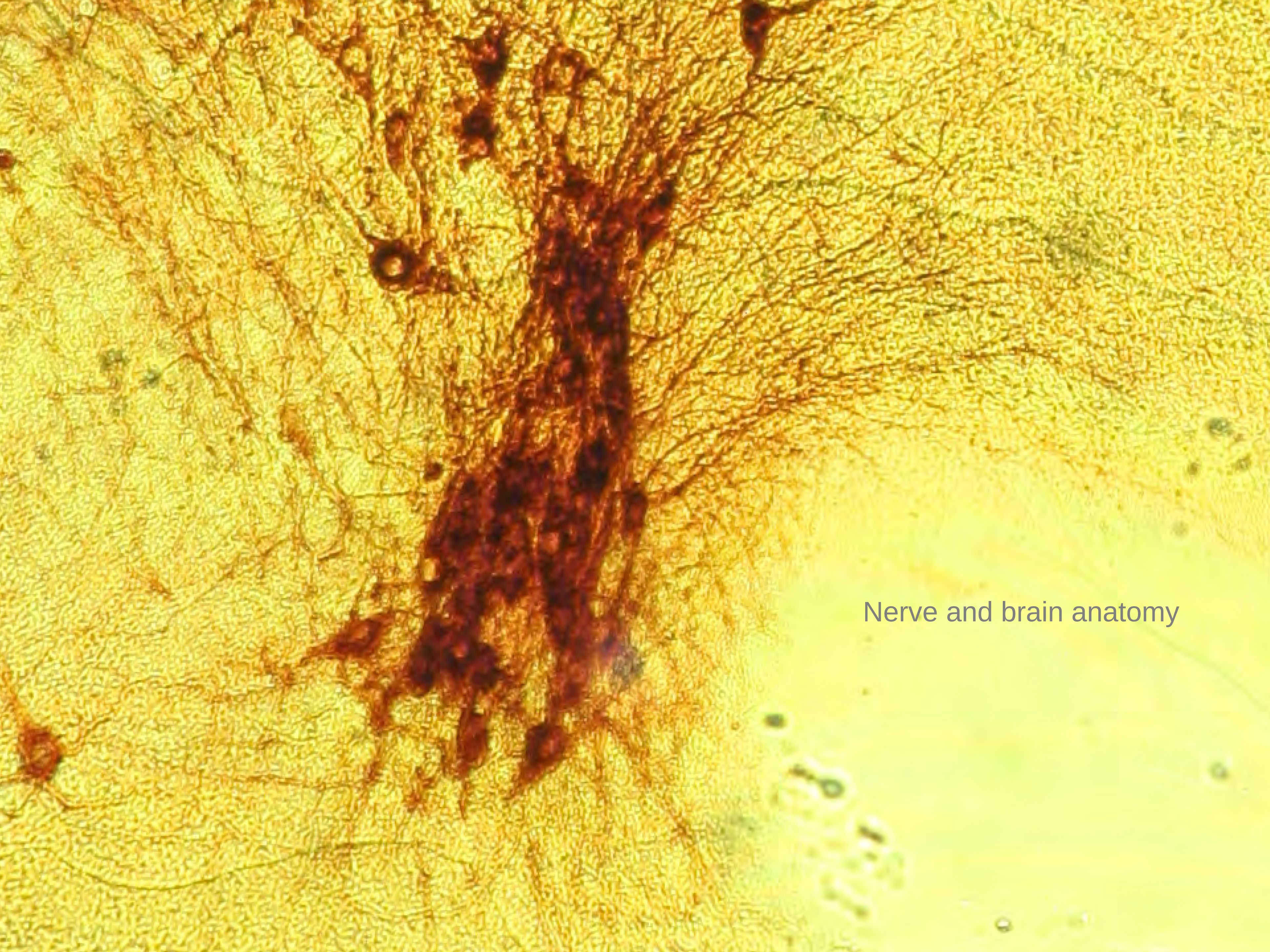
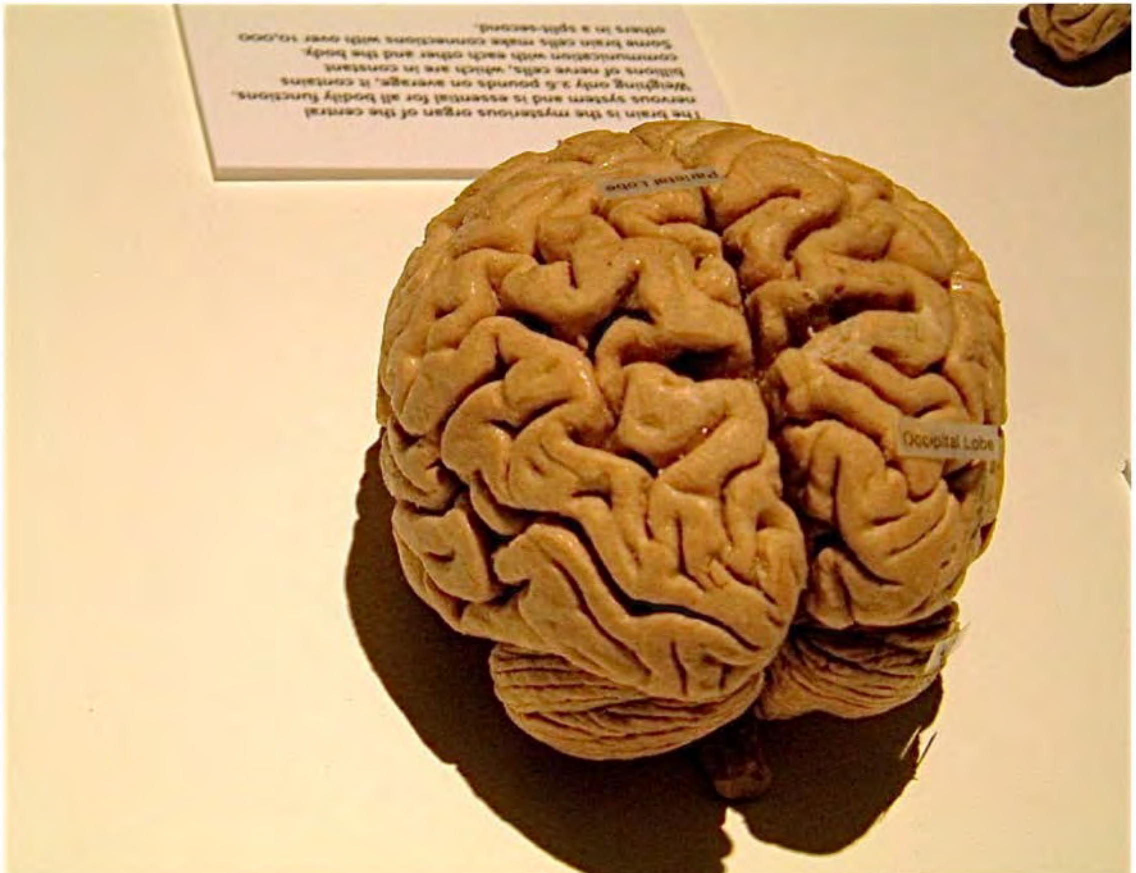
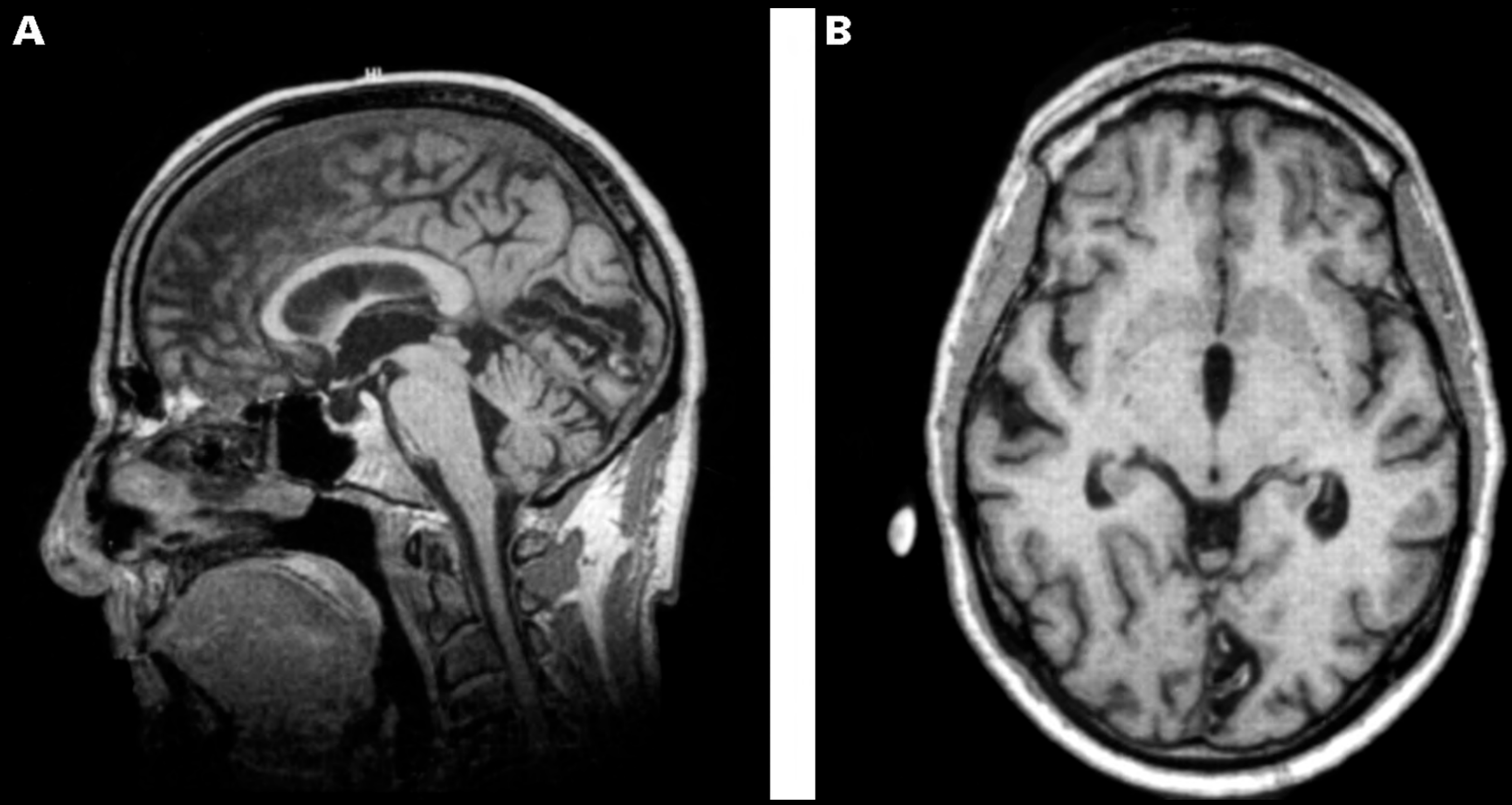
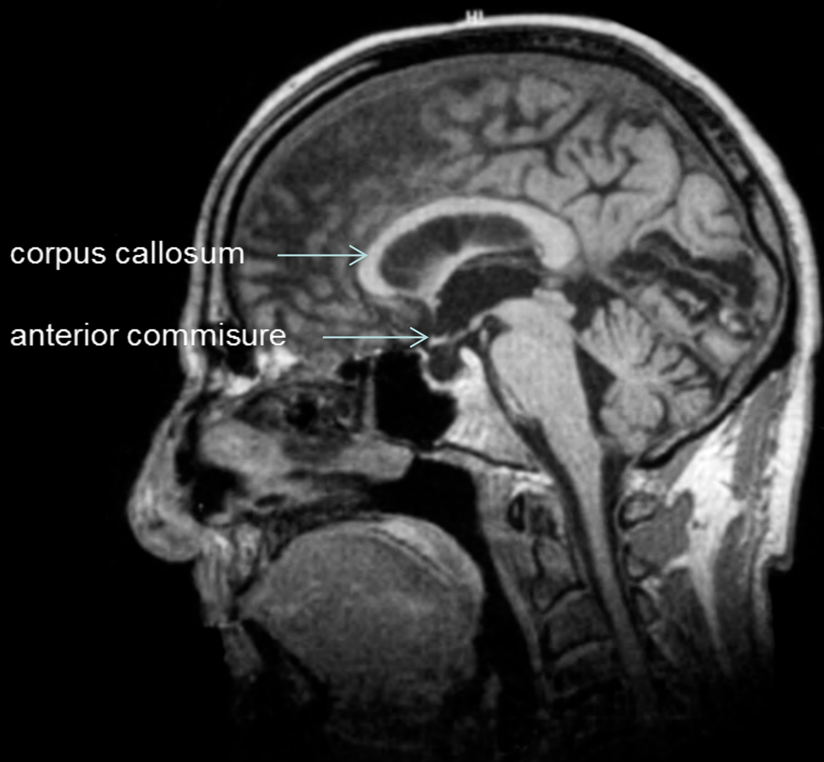

Nerve and brain anatomy

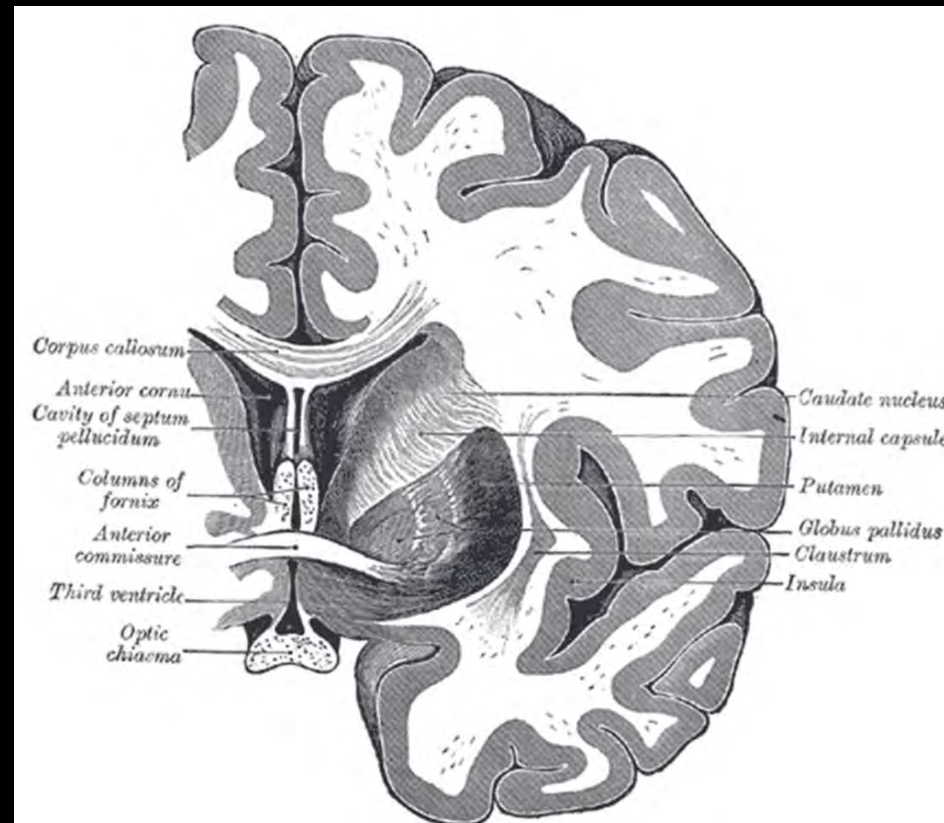

The brain is the mysterious organ of the central
nervous system and is essential for all bodily functions.
Weighing only 2.6 pounds on average, it contains
billions of nerve cells, which are in constant
communication with each other and the body.
Some brain cells make connections with over 10,000
others in a split-second.
Parietal Lobe
Occipital Lobe



Gray substance/White substance

A


corpus callosum
anterior commisure


Corpus callosum
Anterior cornu
Cavity of septum pellucidum
Columns of fornix
Anterior commissure
Third ventricle
Optic chiasma
Caudate nucleus
Internal capsule
Putamen
Globus pallidus
Claustrum
Insula

The macro anatomy of the brain

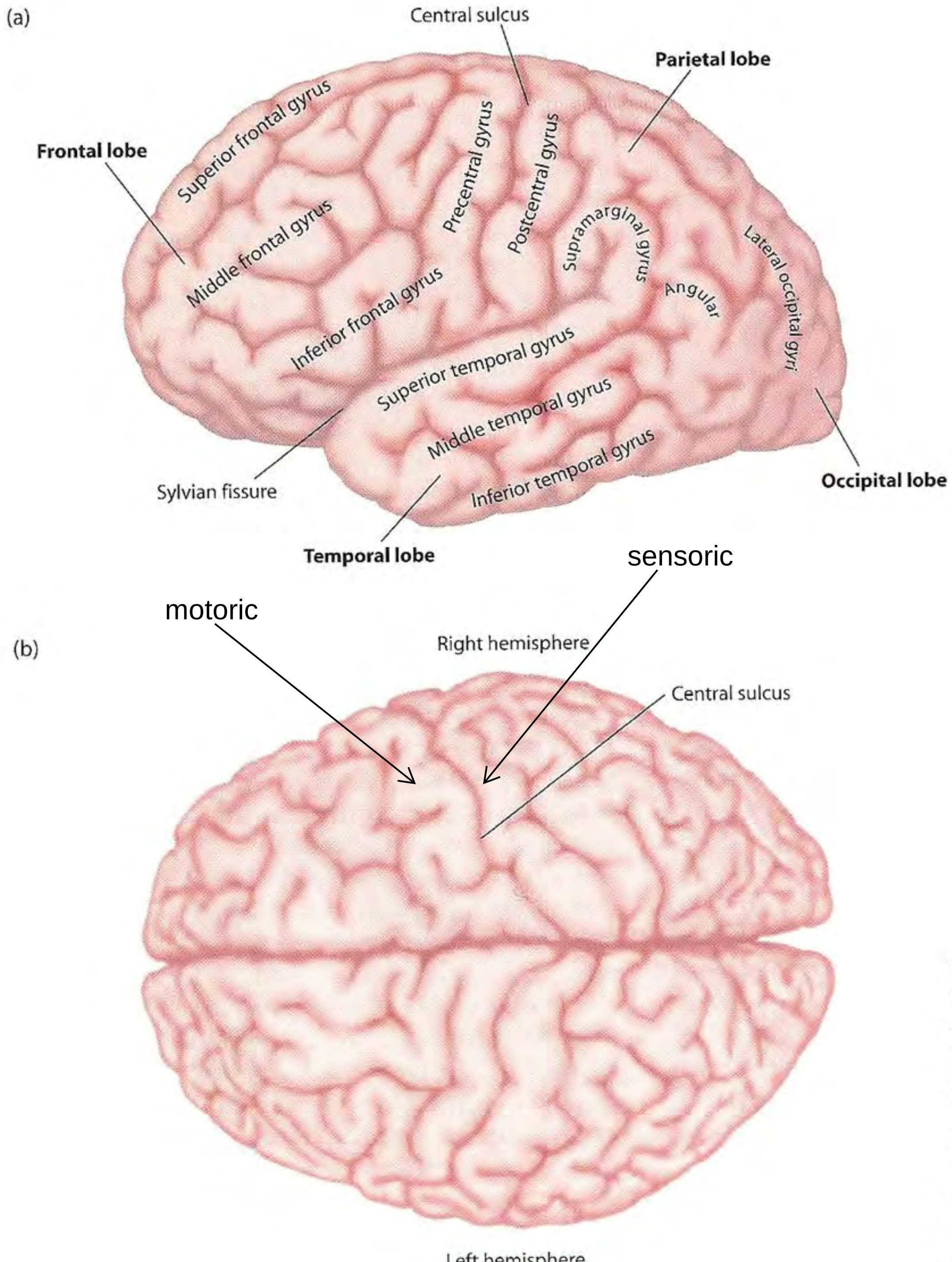
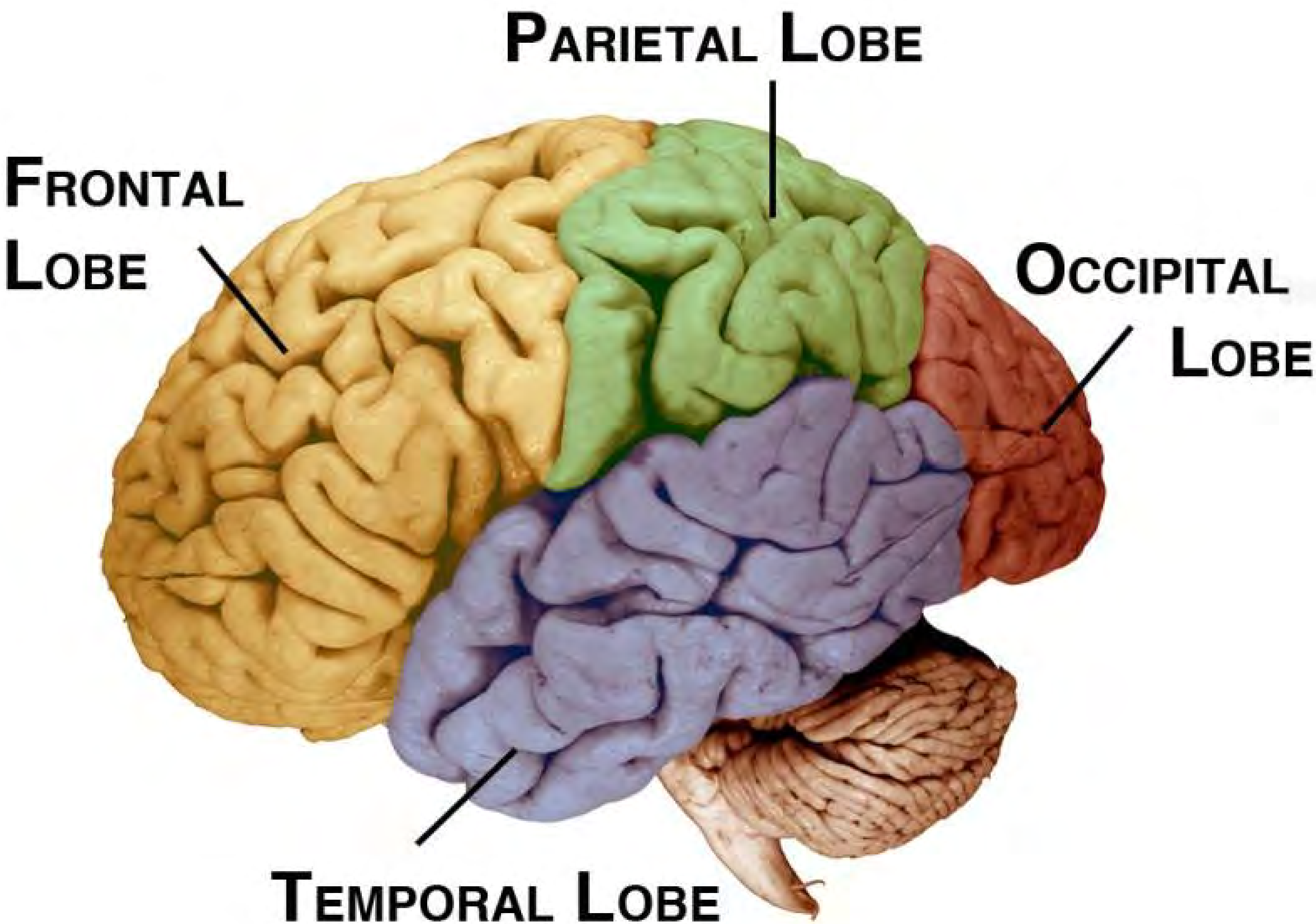


Figure 3.8 Lateral view of the left hemisphere **(a)** and dorsal view of the cerebral cortex **(b)** in humans. The major features of the cortex include the four cortical lobes and various key gyri. Gyri are separated by sulci and result from the folding of the cerebral cortex that occurs during development of the nervous system, to achieve an economy of size.


PARIETAL LOBE
FRONTAL LOBE
OCCIPITAL LOBE
TEMPORAL LOBE

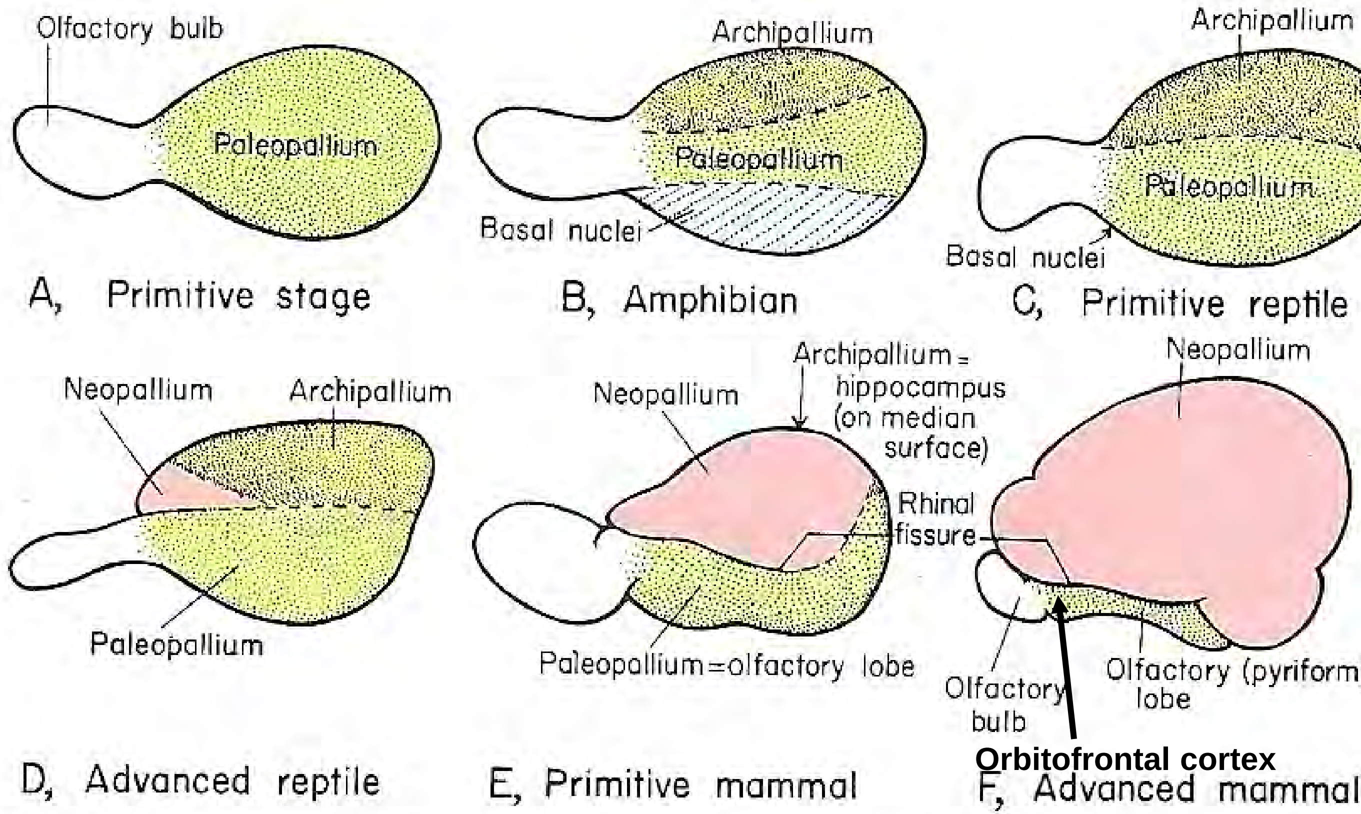
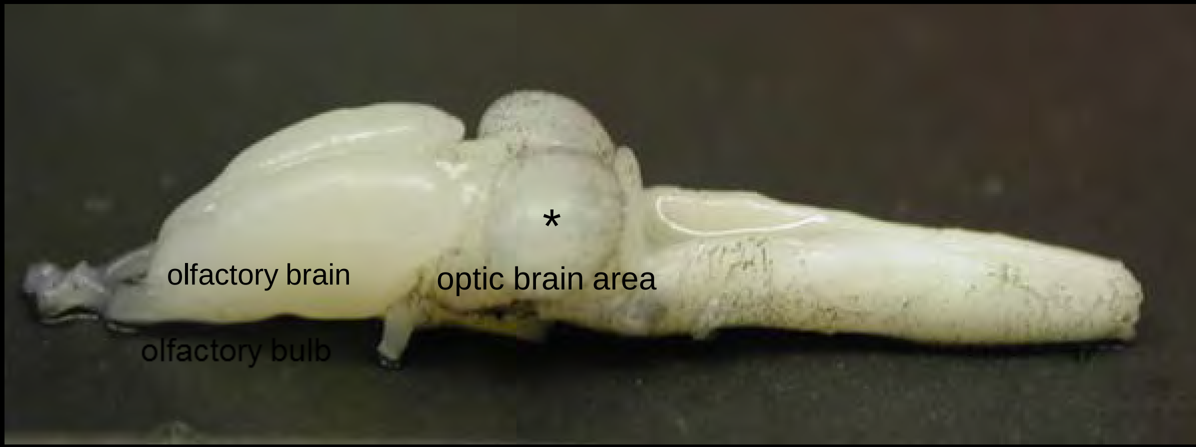
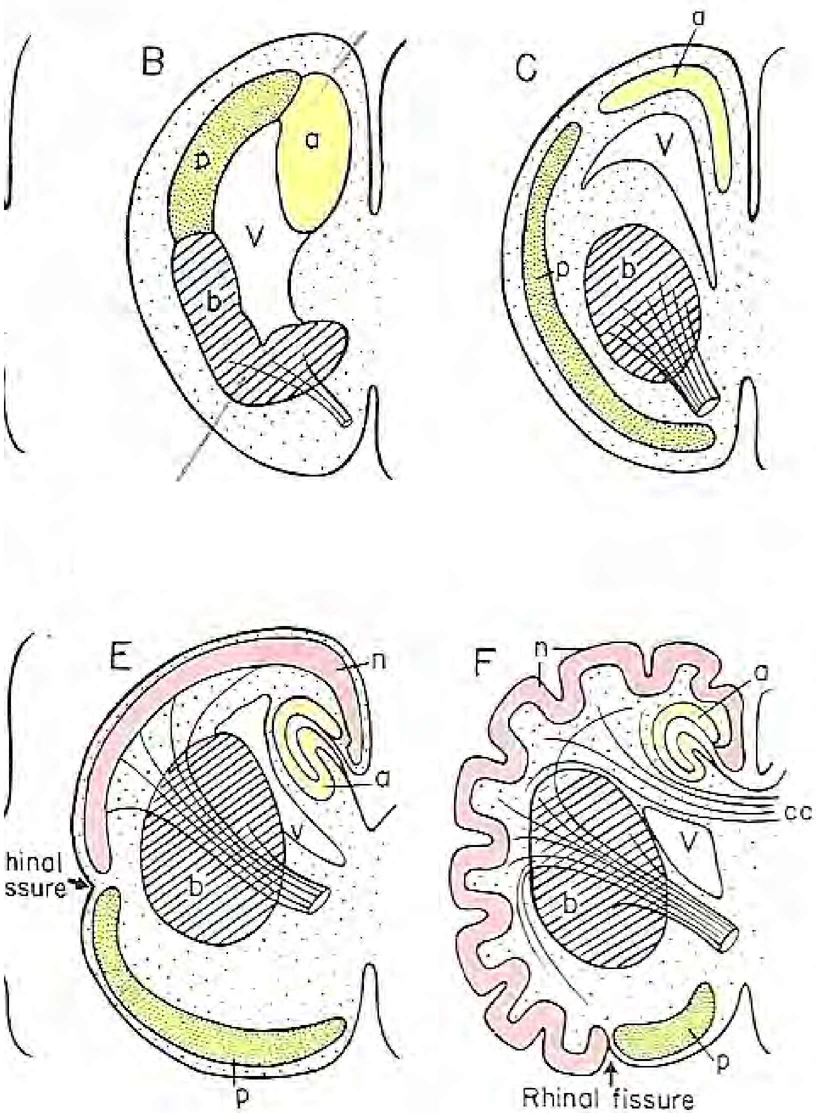


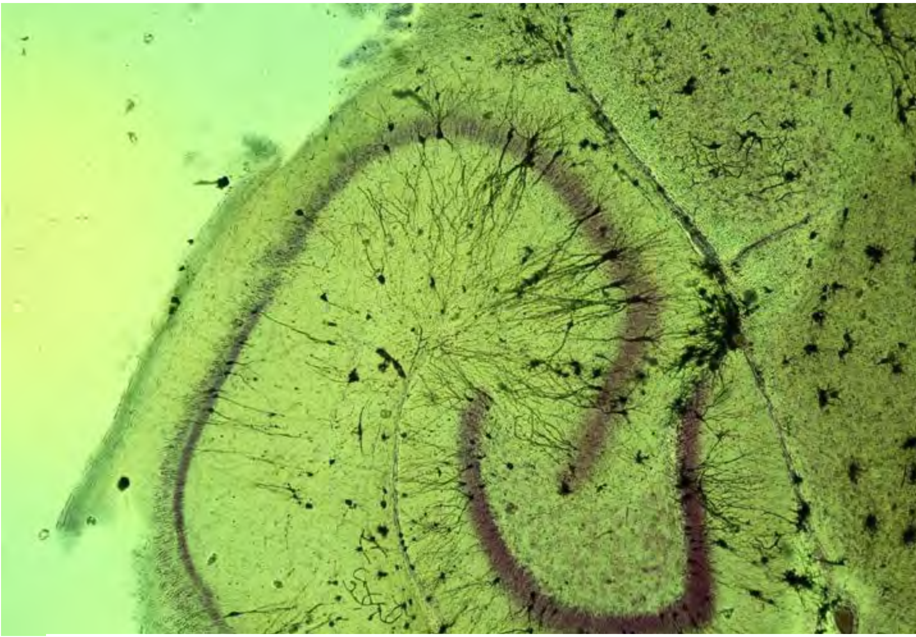
Figure 417. Diagrams to show progressive differentiation of the cerebral hemisphere (cf. Fig. 418). Lateral views of left hemisphere and olfactory bulb. In *A* the hemisphere is merely an olfactory lobe. *B,* Dorsal and ventral areas, archipallium (= hippocampus) and basal nuclei (corpus striatum) are differentiated. *C,* The basal nuclei have moved to the inner part of the hemisphere. *D,* The neopallium appears as a small area (in many reptiles). *E,* The archipallium is forced to the median surface, but the neopallium is still of modest dimensions, and the olfactory areas are still prominent below the rhinal fissure (as in primitive mammals). *F,* The primitive olfactory area is restricted to the ventral aspect, and the neopallial areas are greatly enlarged (as in advanced mammals). The various cellular components of the hemispheres are distinguished by color.

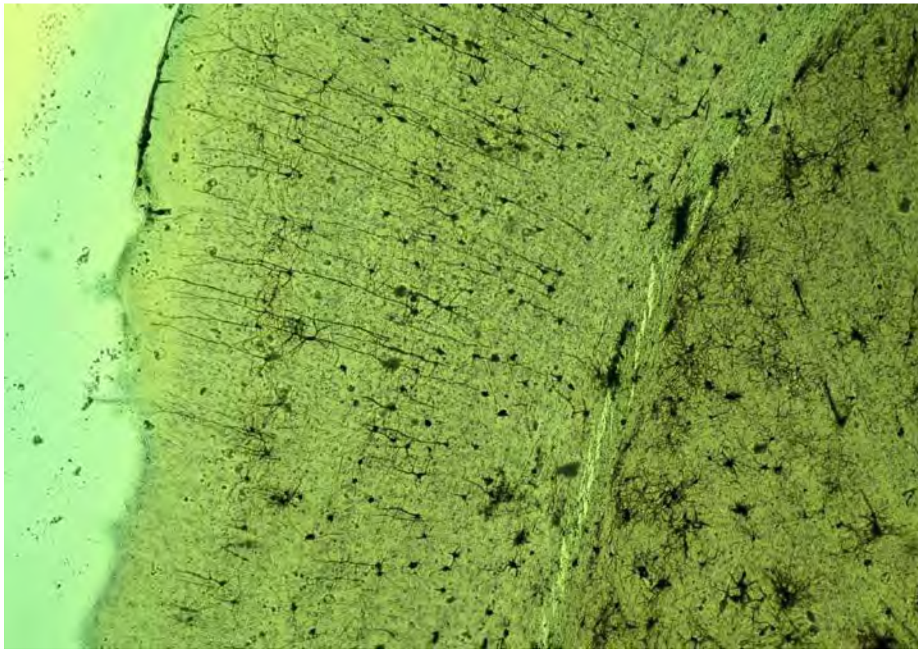


*
olfactory brain
optic brain area
olfactory bulb

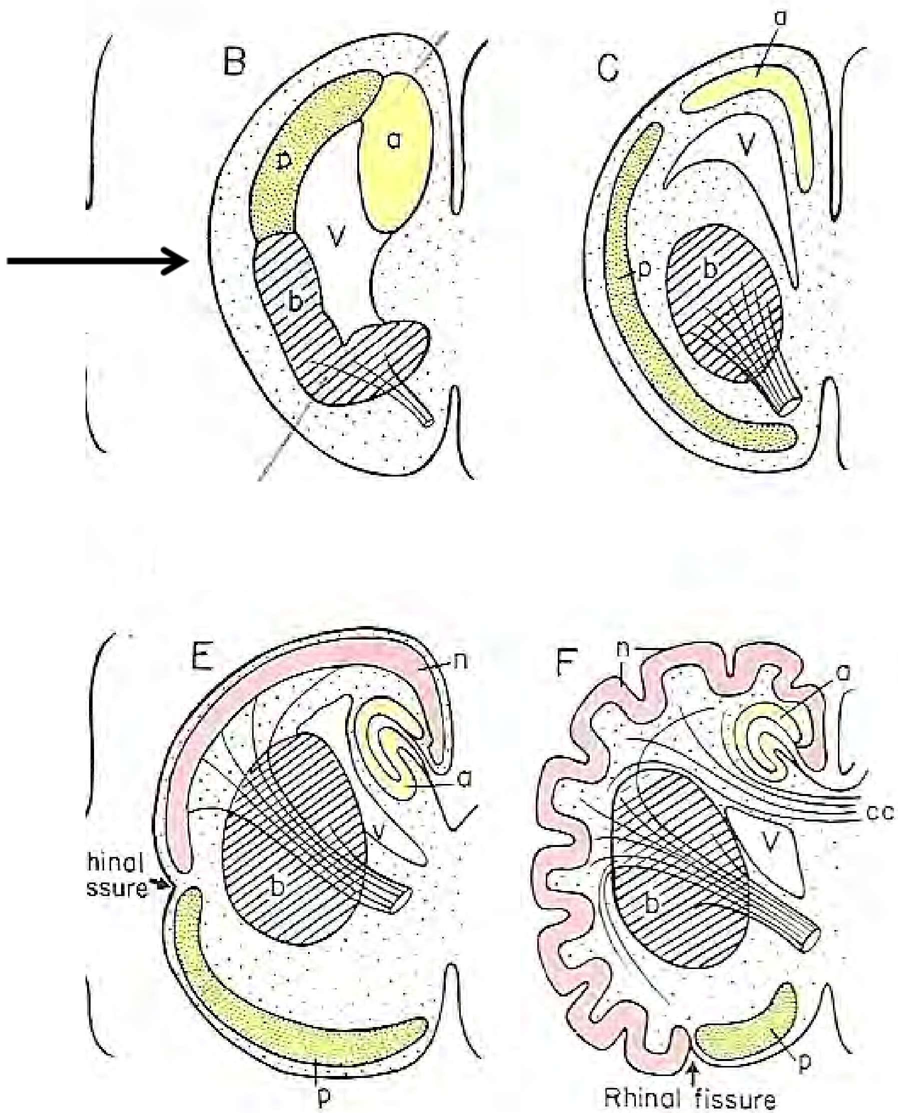
Mind the development of neocortex (neopallium), and the reduction of paleocortex (paralimbic structures) and archicortex (hippocampus)

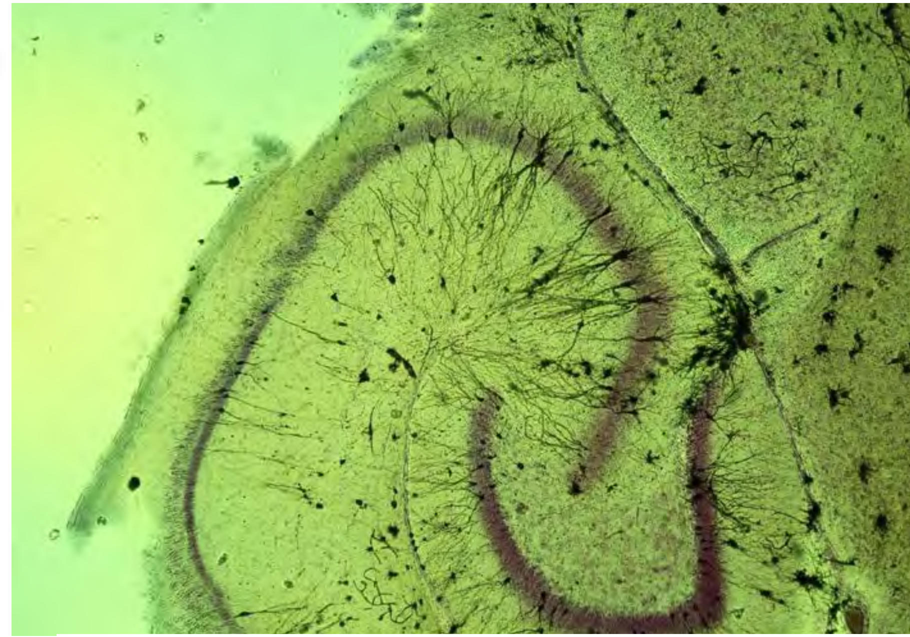


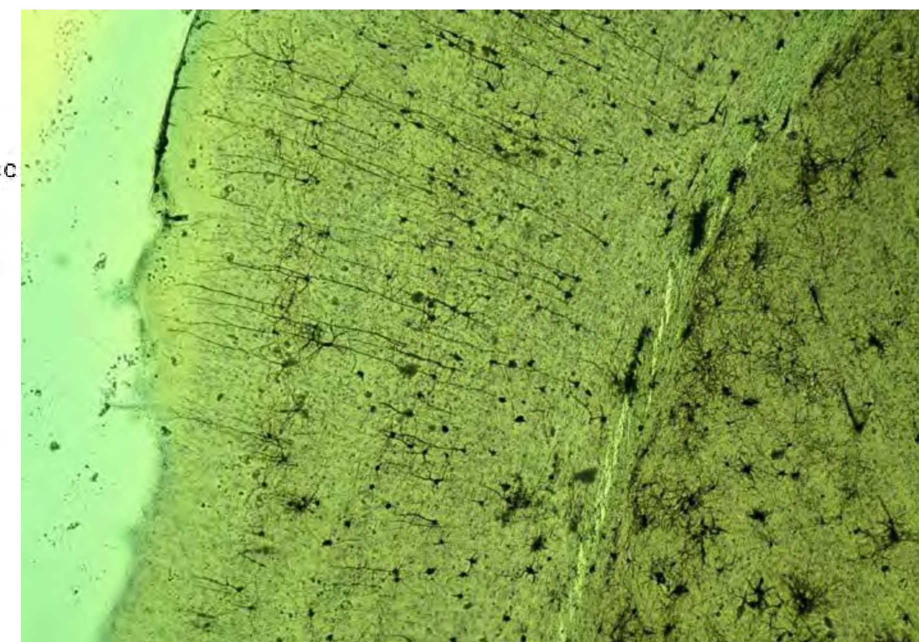




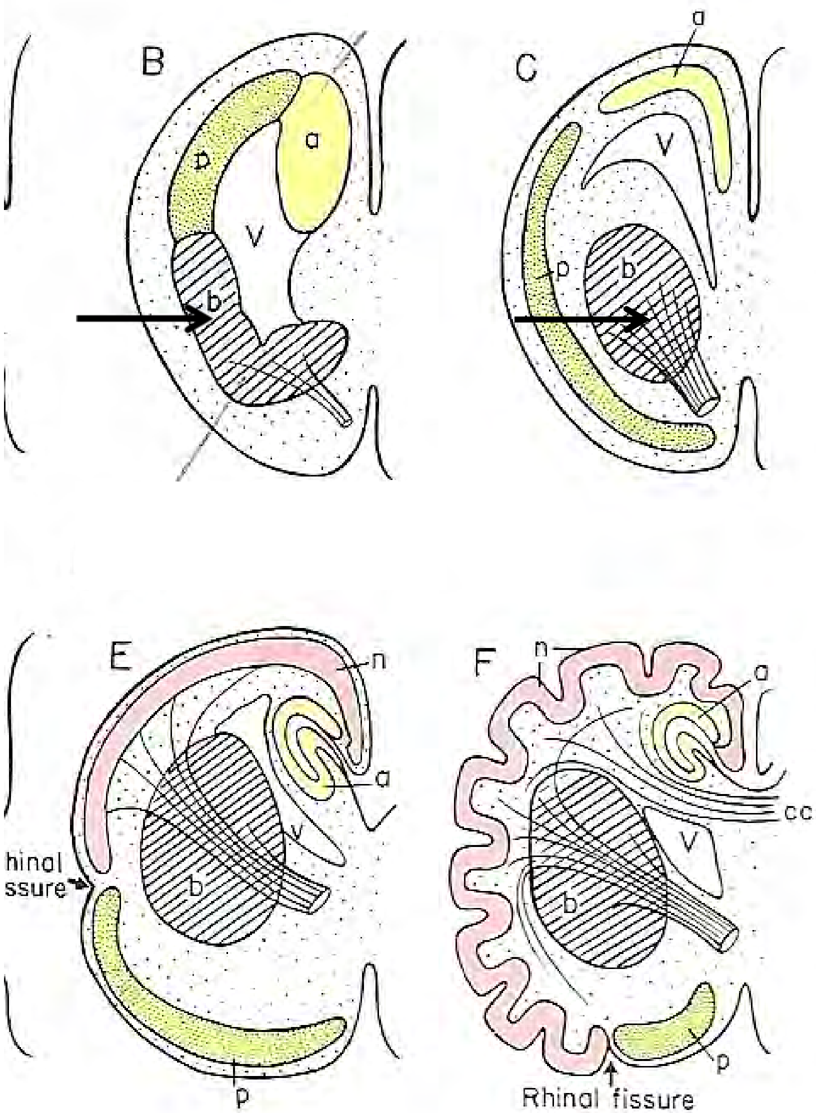
Mind the development of neocortex (neopallium), and the reduction of paleocortex (paralimbic structures) and archicortex (hippocampus)

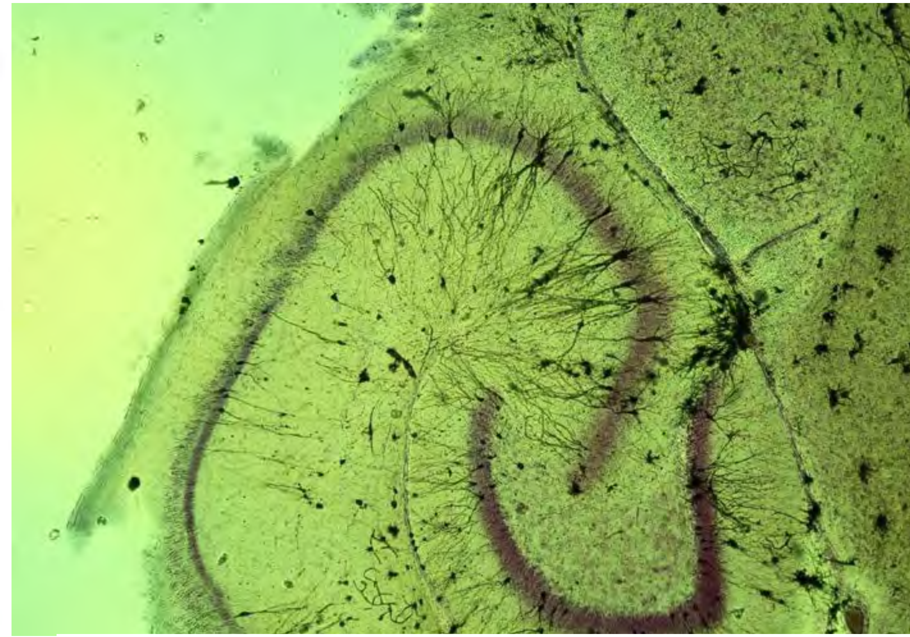


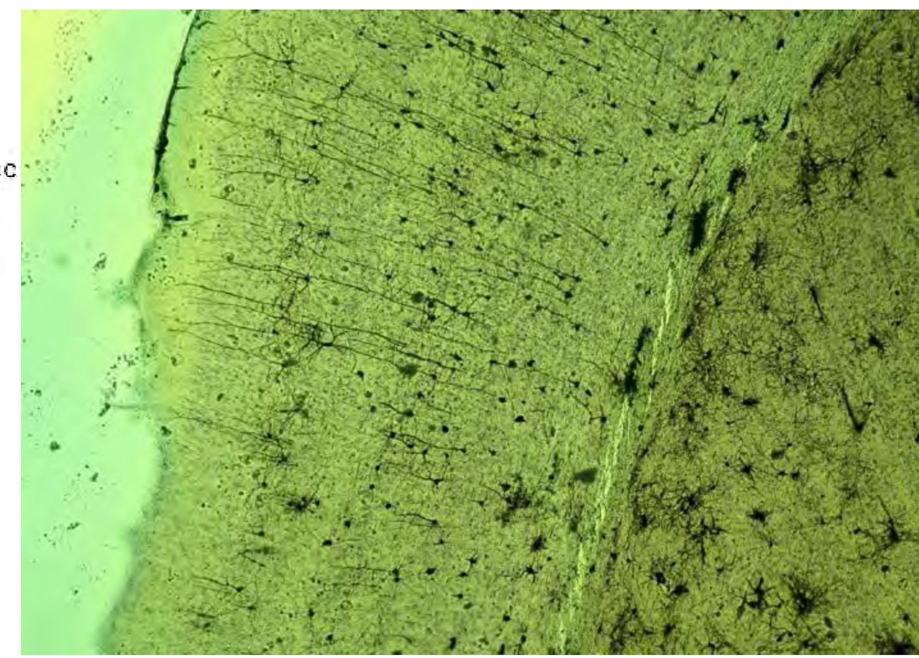




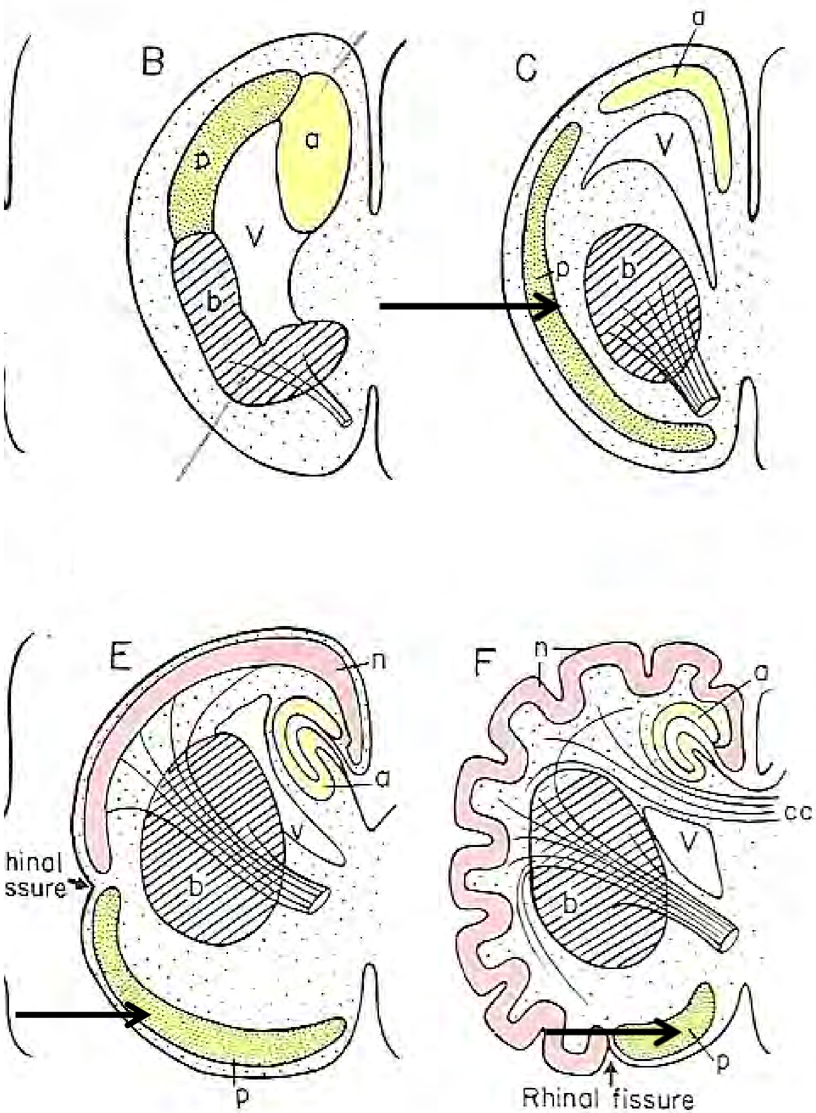
Mind the development of neocortex (neopallium), and the reduction of paleocortex (paralimbic structures) and archicortex (hippocampus)

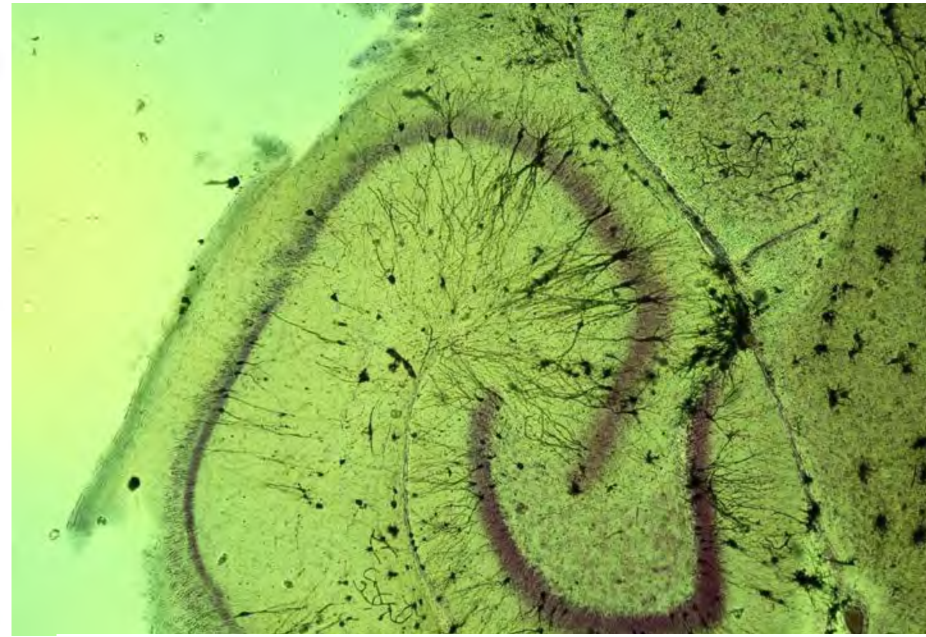


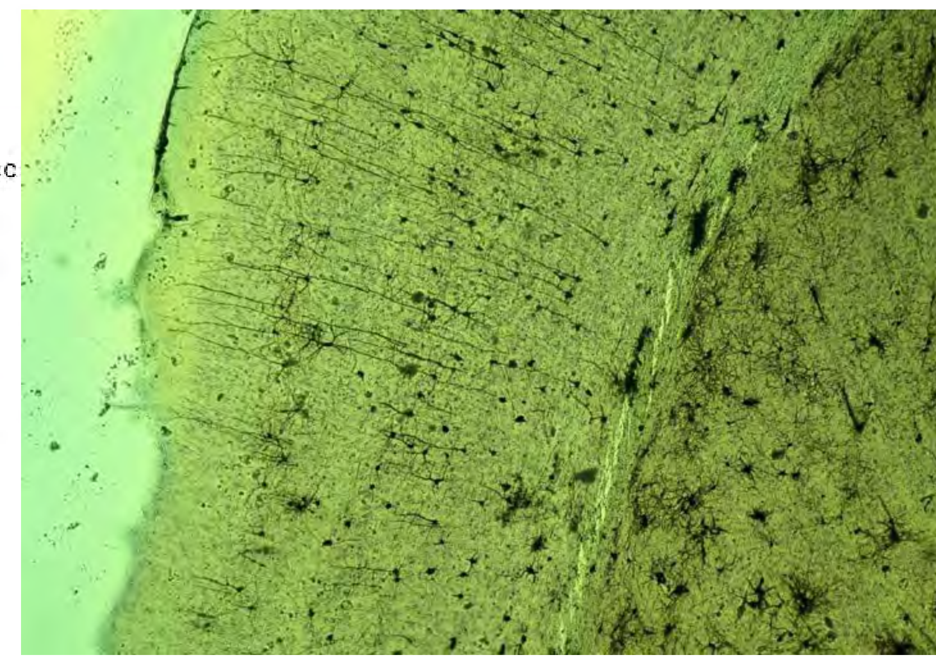




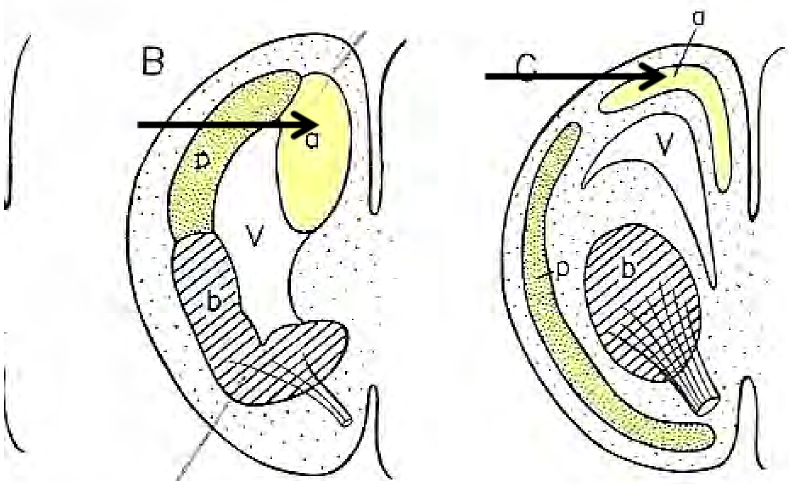
Mind the development of neocortex (neopallium), and the reduction of paleocortex (paralimbic structures) and archicortex (hippocampus)

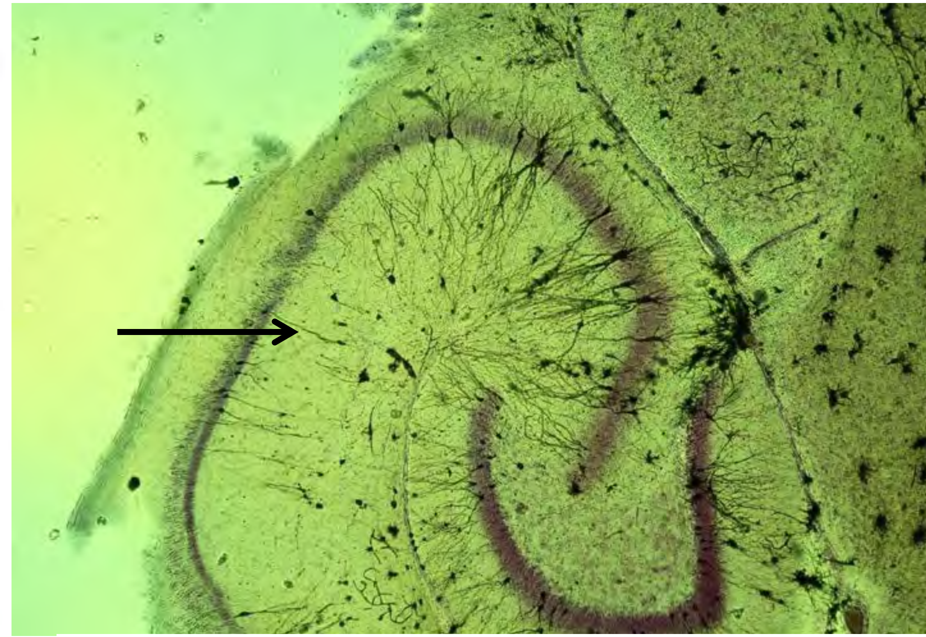


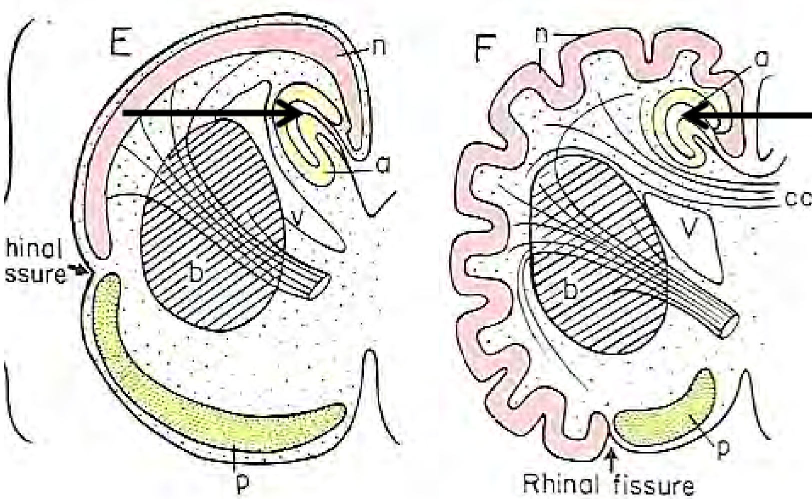


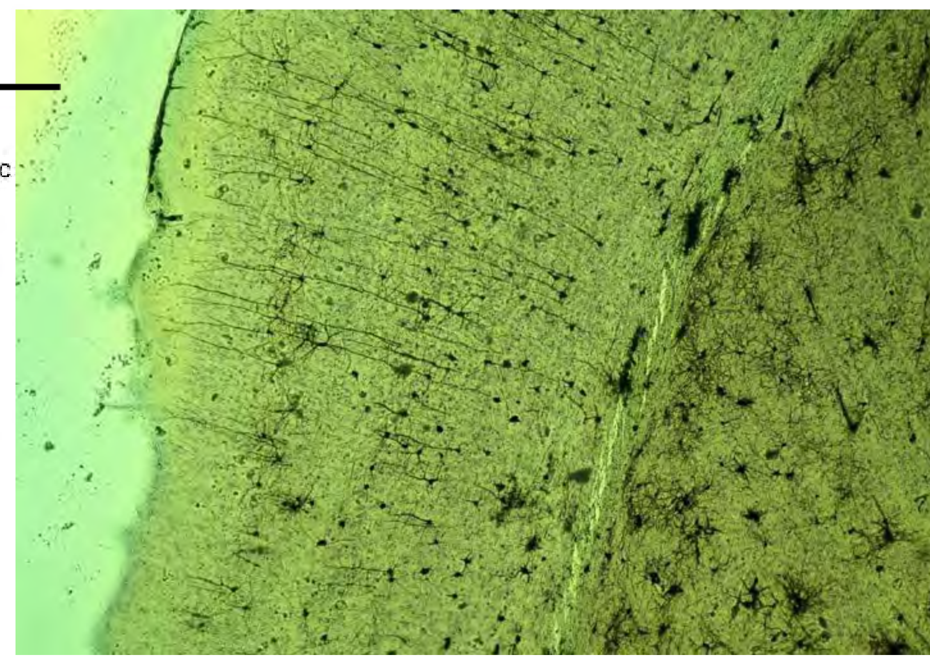


Mind the development of neocortex (neopallium), and the reduction of paleocortex (paralimbic structures) and archicortex (hippocampus)

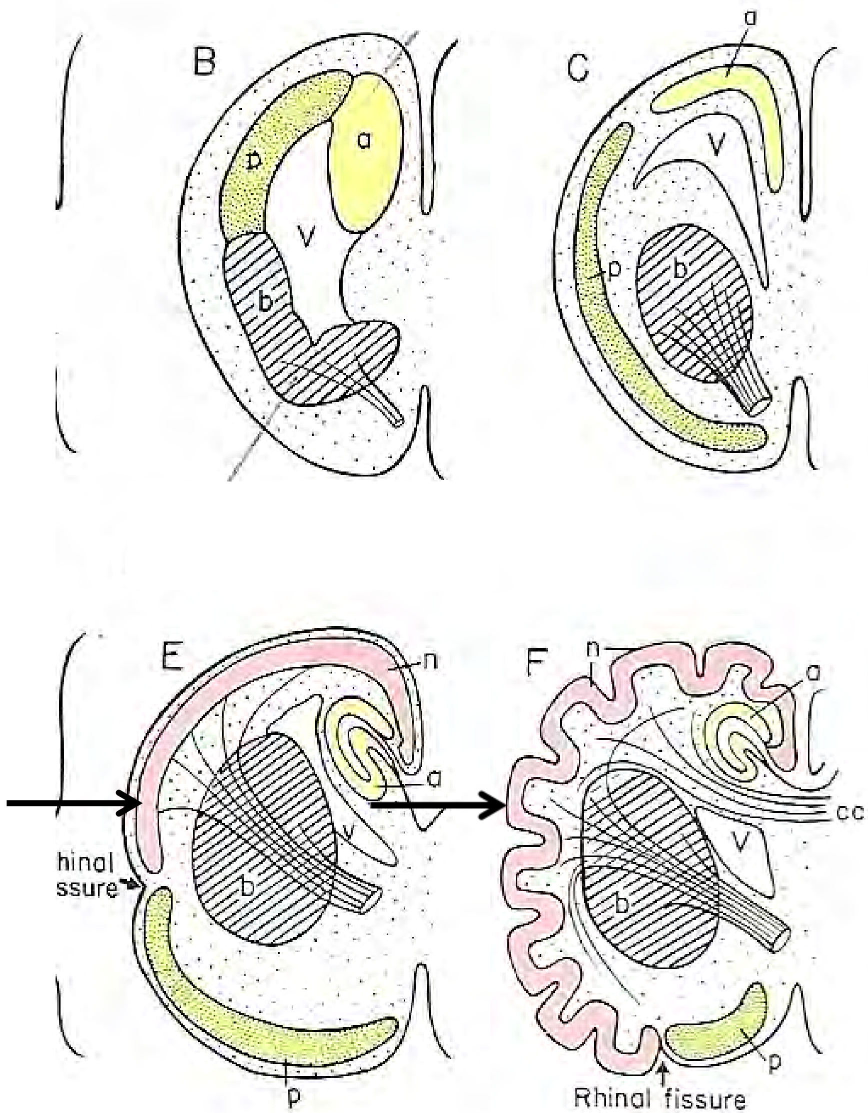


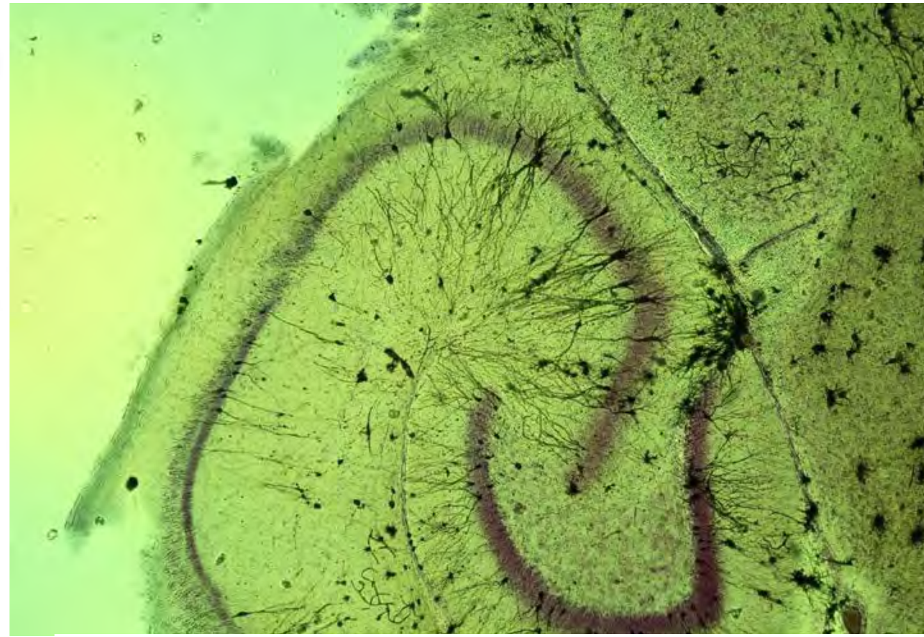


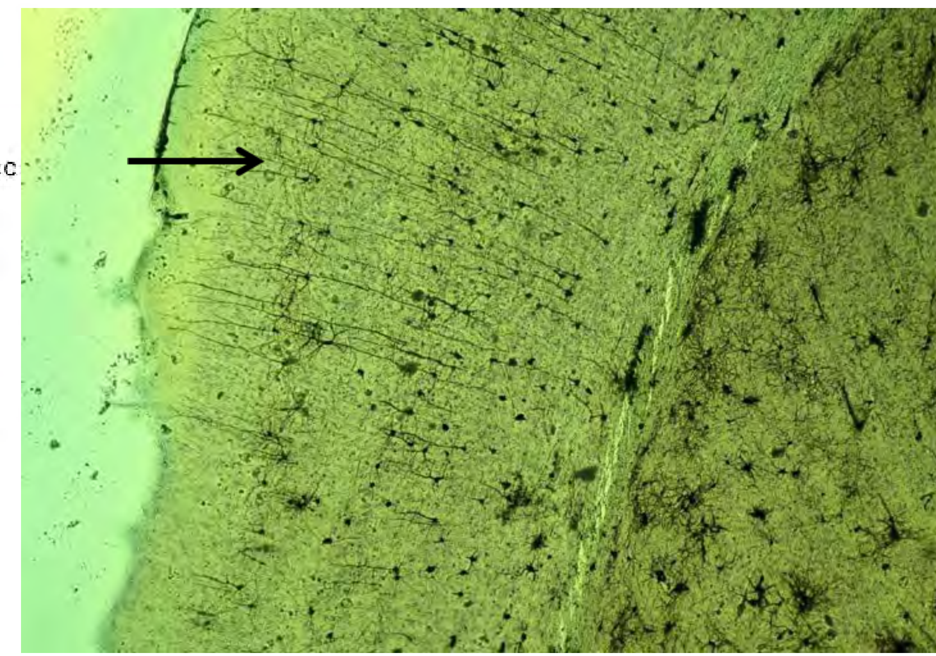




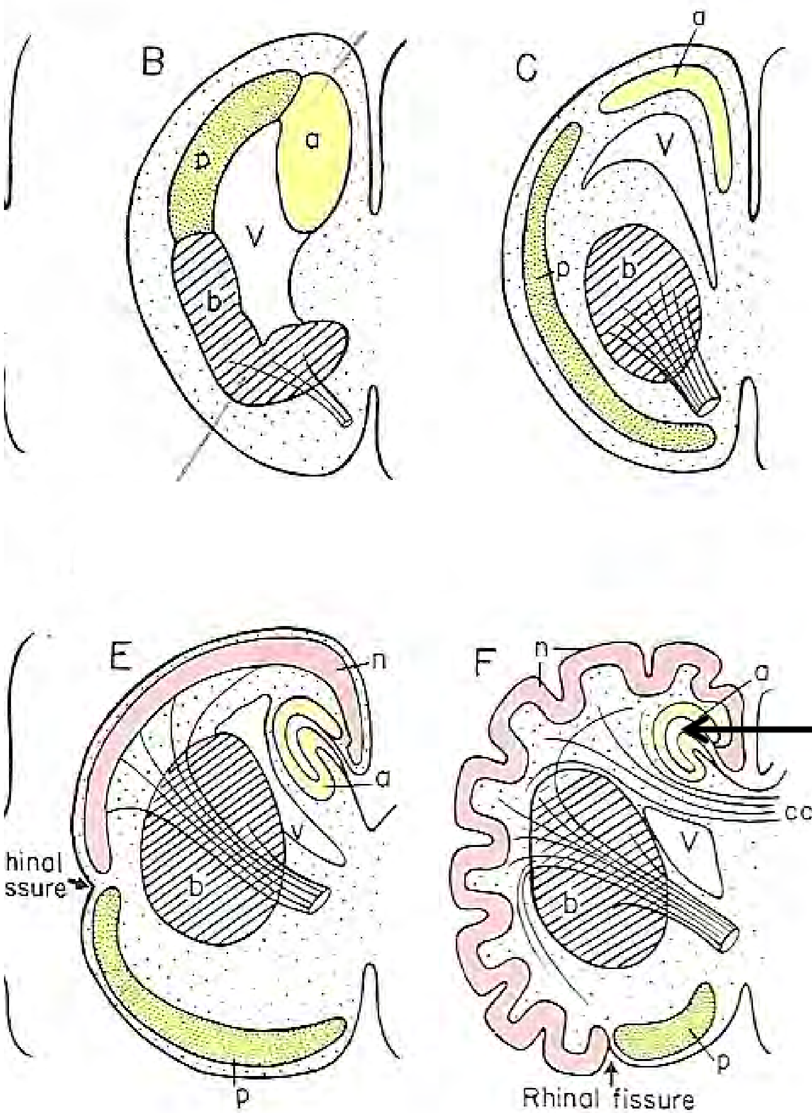
Mind the development of neocortex (neopallium), and the reduction of paleocortex (paralimbic structures) and archicortex (hippocampus)

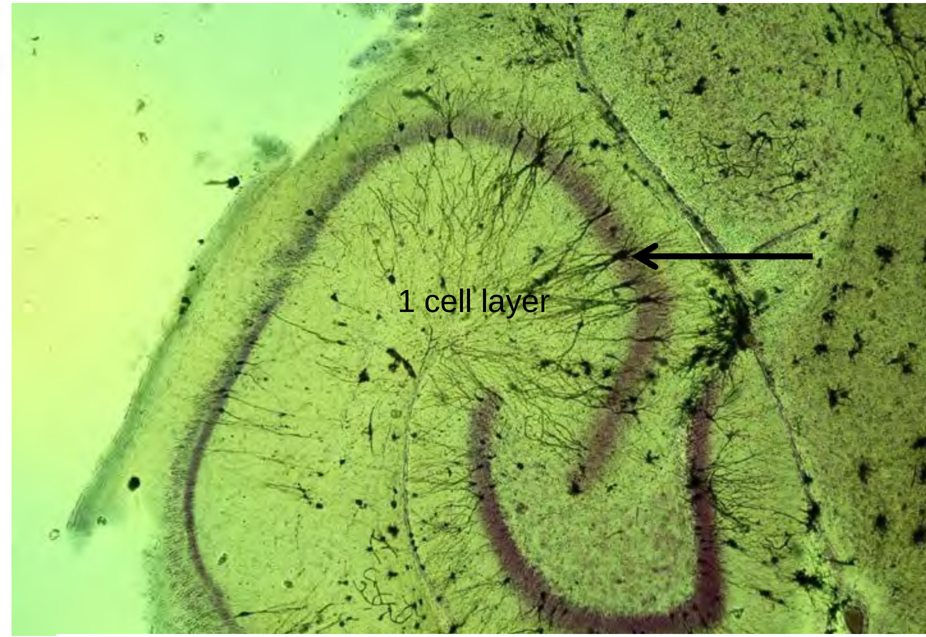


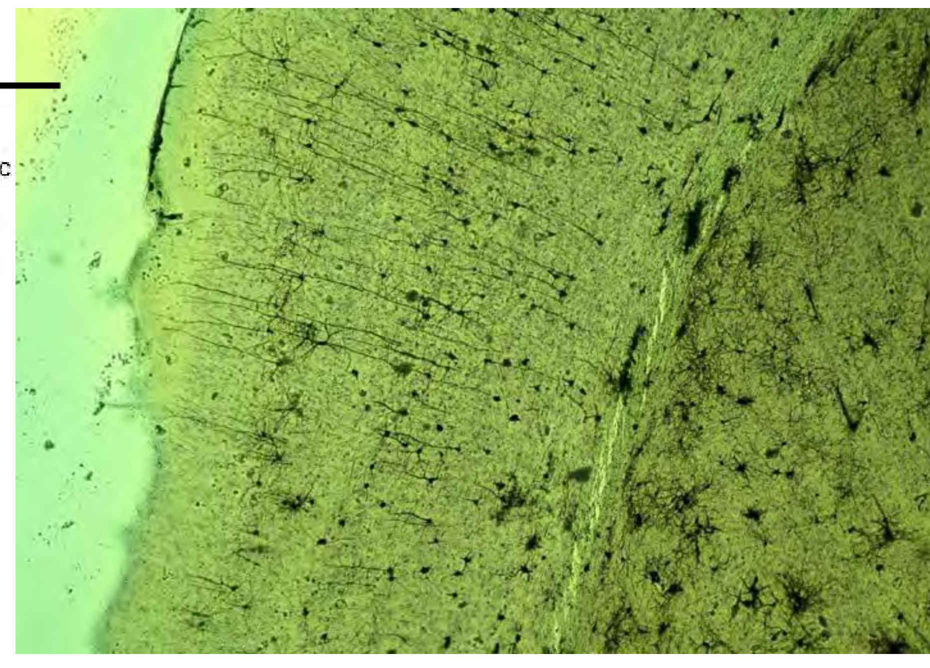




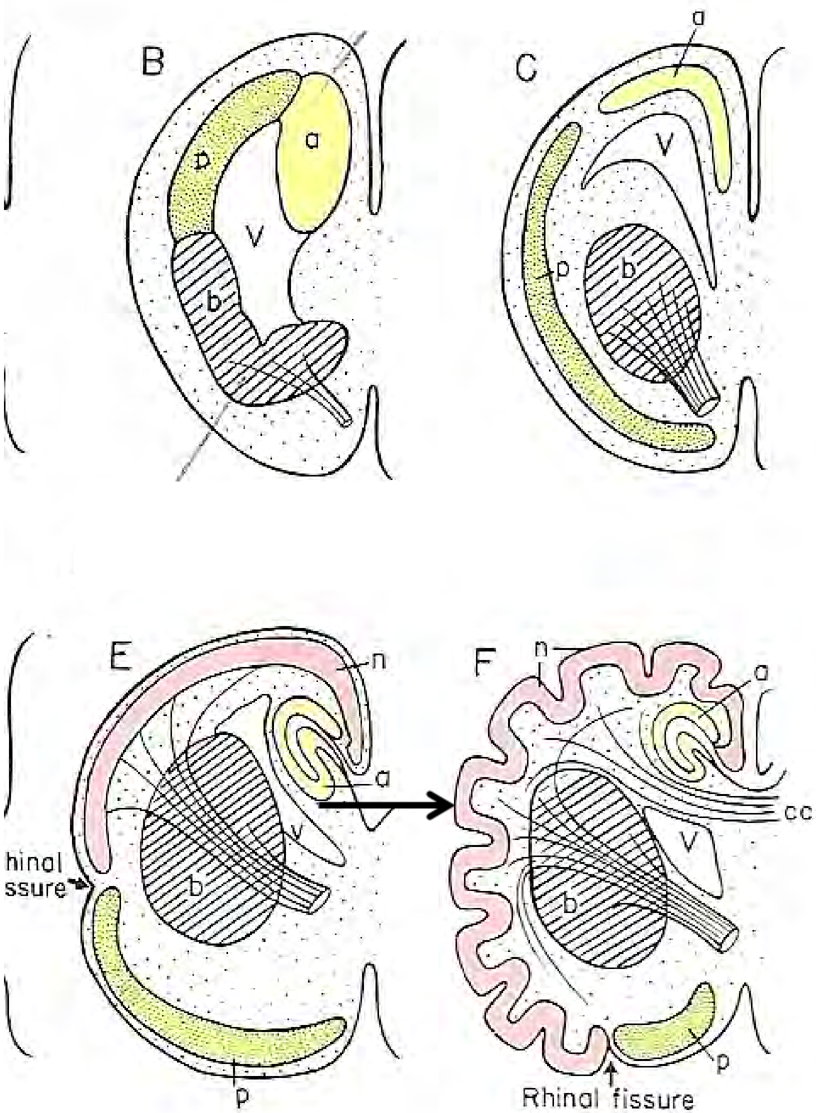
Mind the development of neocortex (neopallium), and the reduction of paleocortex (paralimbic structures) and archicortex (hippocampus)

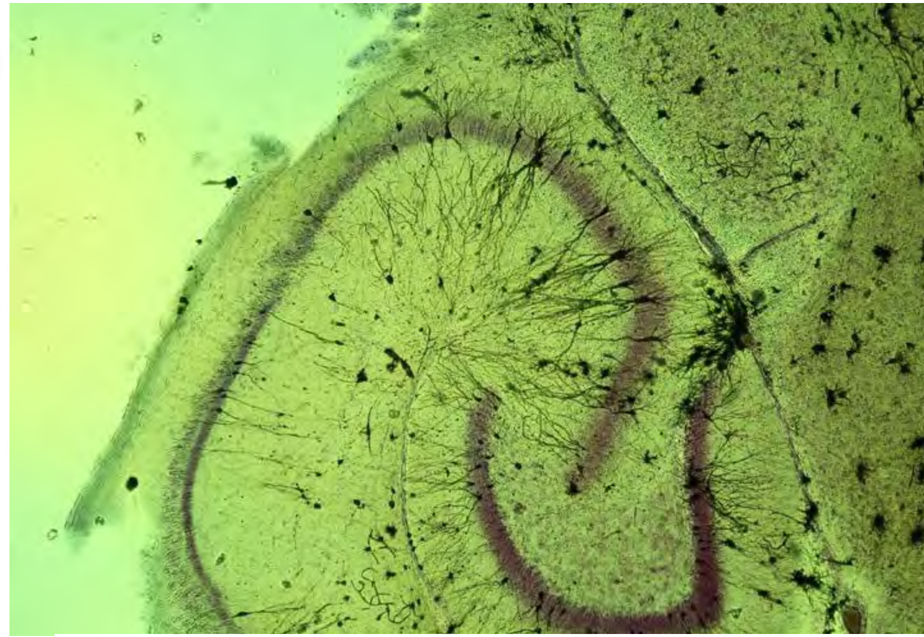


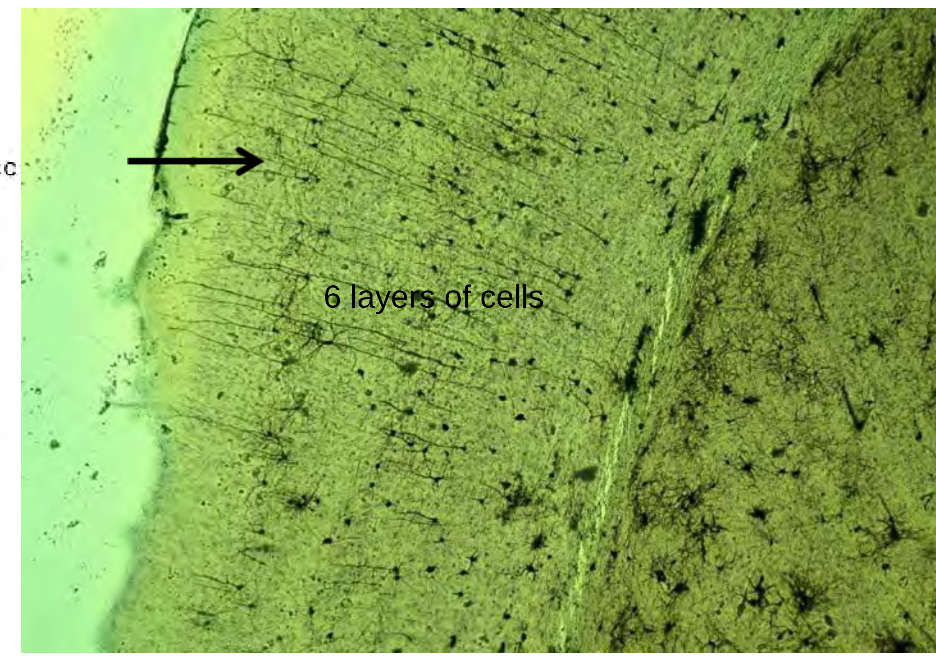


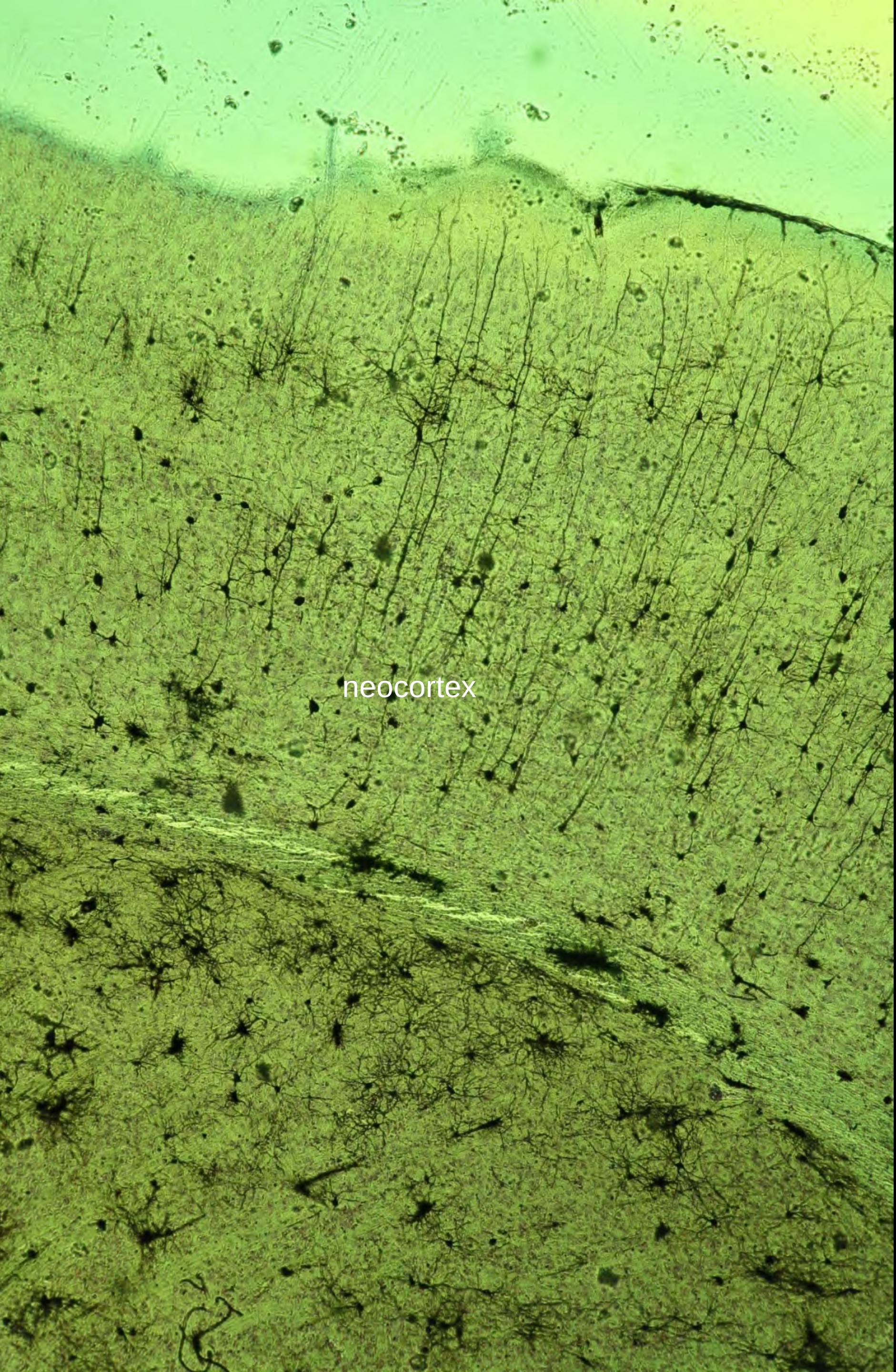


Mind the development of neocortex (neopallium), and the reduction of paleocortex (paralimbic structures) and archicortex (hippocampus)



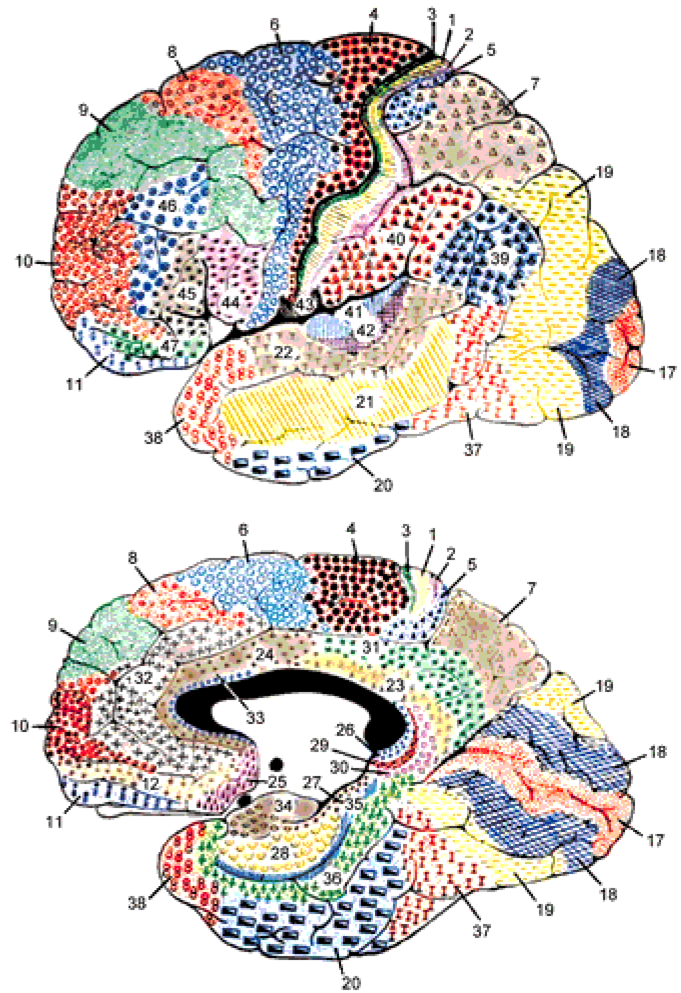





neocortex


archicortex: hippocampus

Korbinian Brodman's (1909-1960)
cytoarchitectonic map of the brain



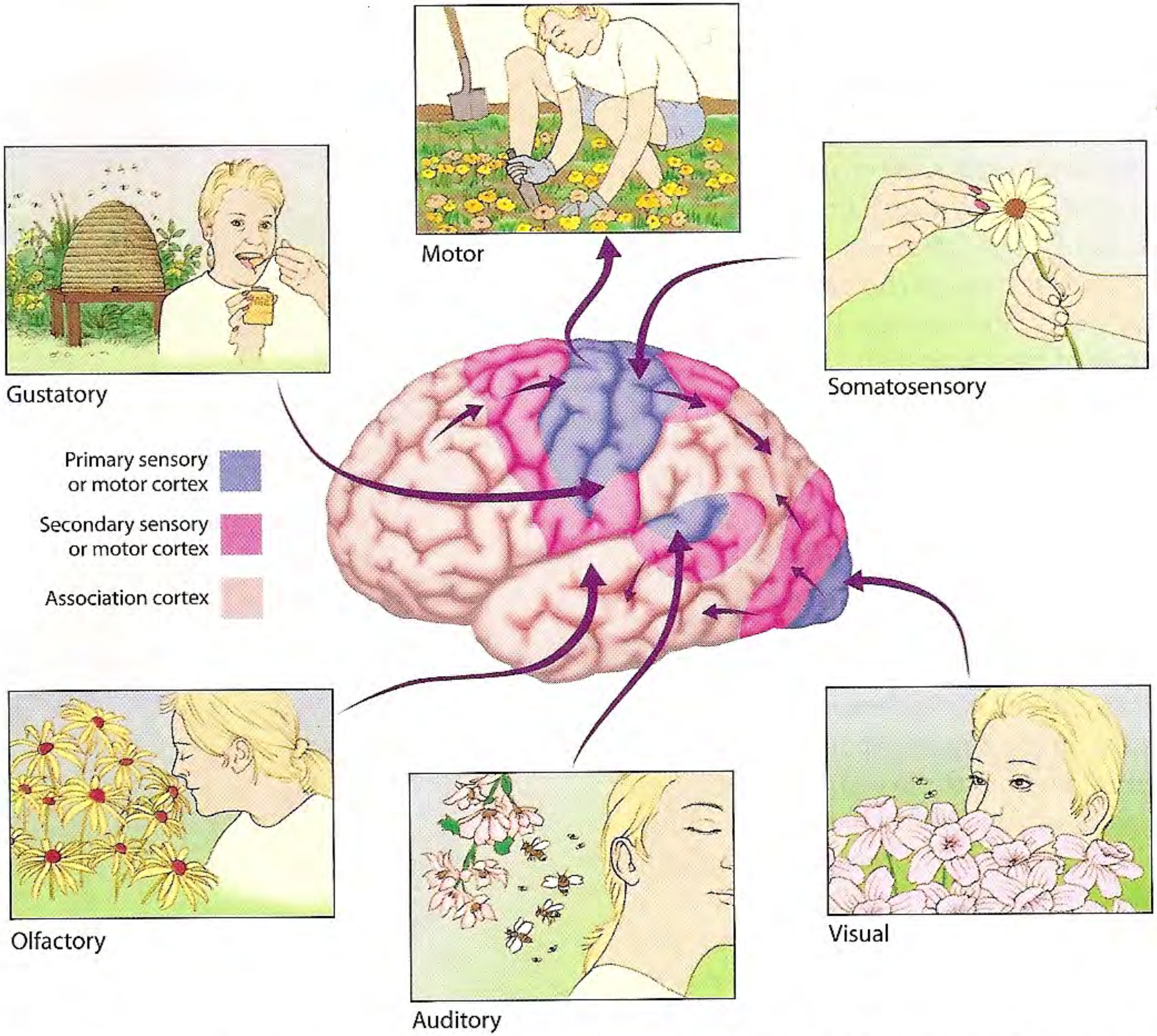


Figure 3.17 Primary sensory and motor cortex and surrounding association cortex. The blue regions show the primary cortical receiving areas of the ascending sensory pathways and the primary output region to the spinal cord. The secondary sensory and motor areas are colored red. The remainder is considered association cortex.

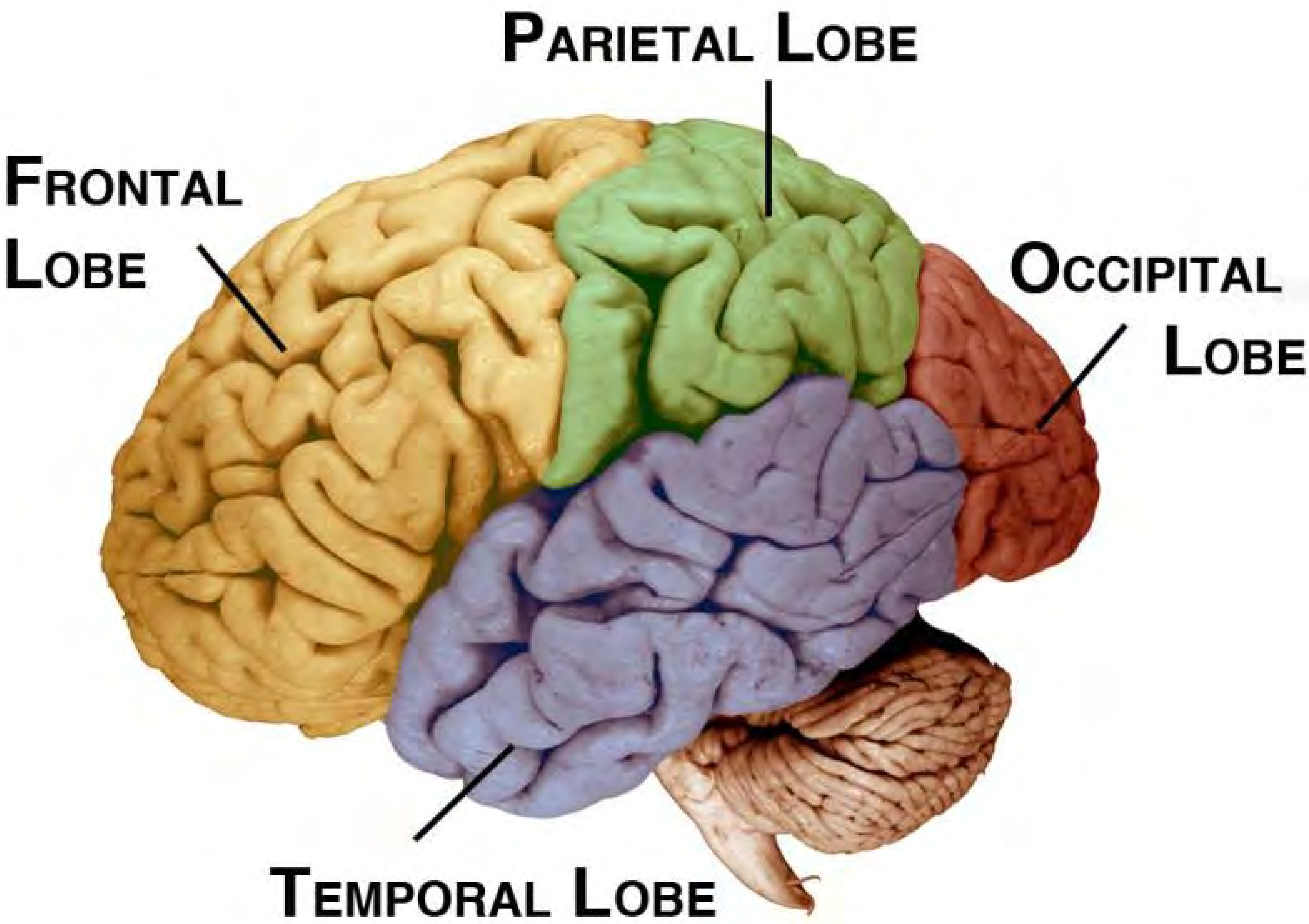
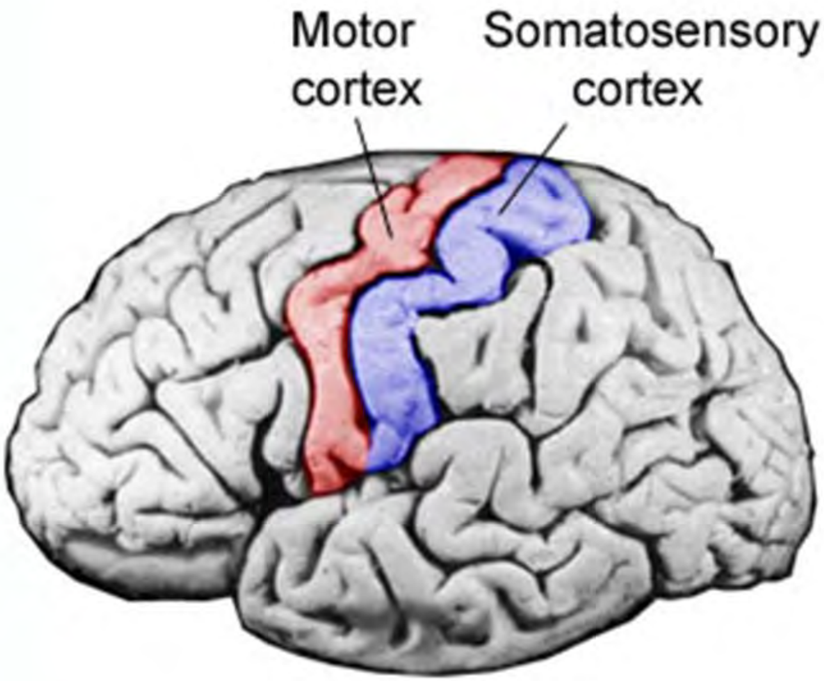
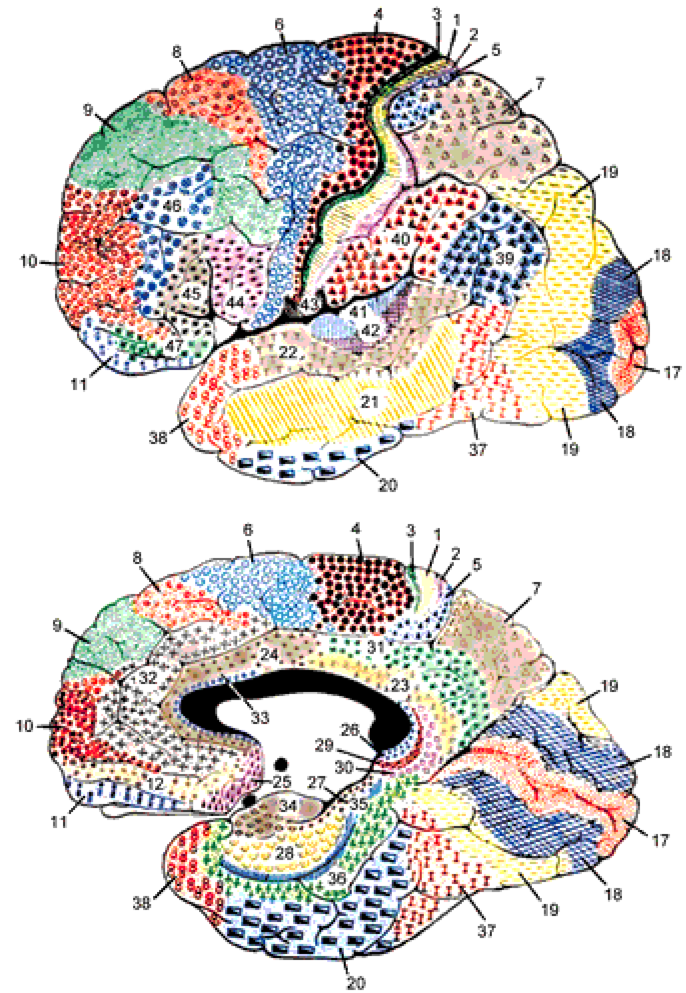

Parietal Lobe
Frontal Lobe
Occipital Lobe
Temporal Lobe

Figure F-3: Motor and Somatosensory Cortex



Korbinian Brodman's (1909-1960)
cytoarchitectonic map of the brain



Korbinian Brodman's (1909-1960) cytoarchitectonic map of the brain

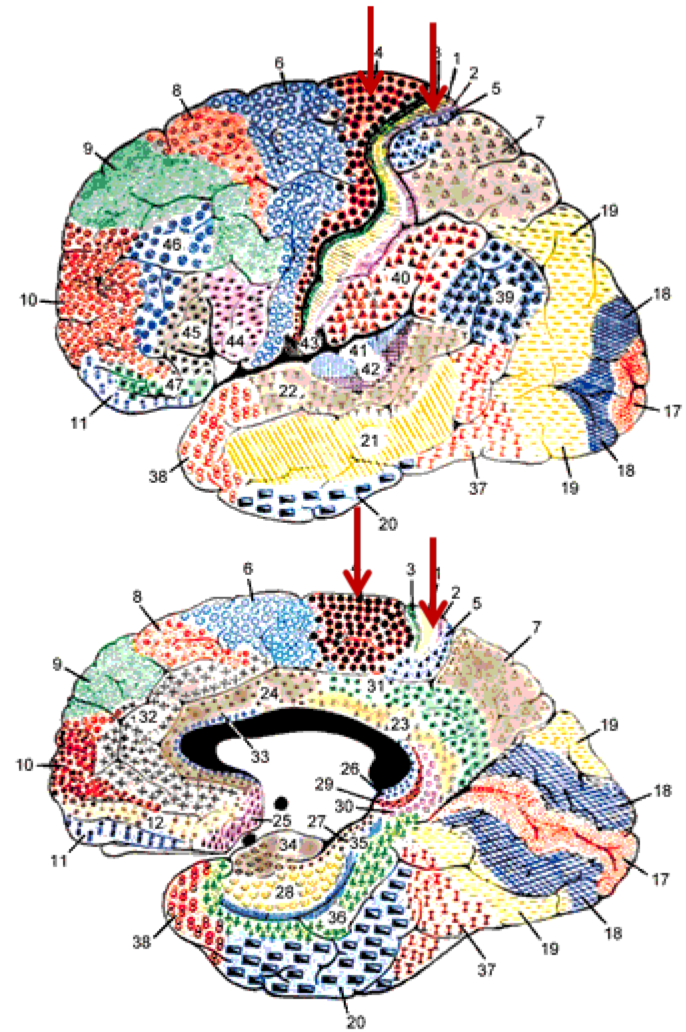
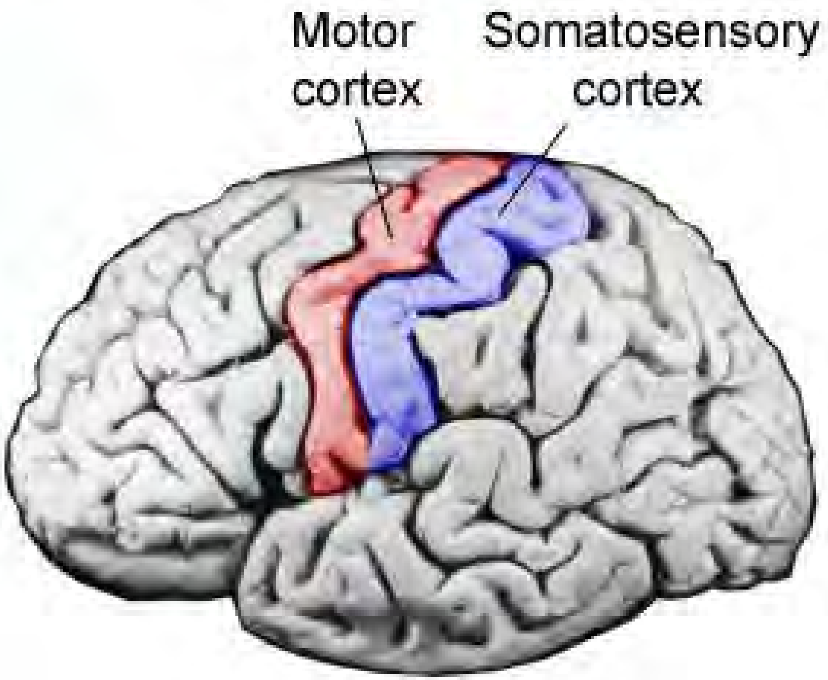
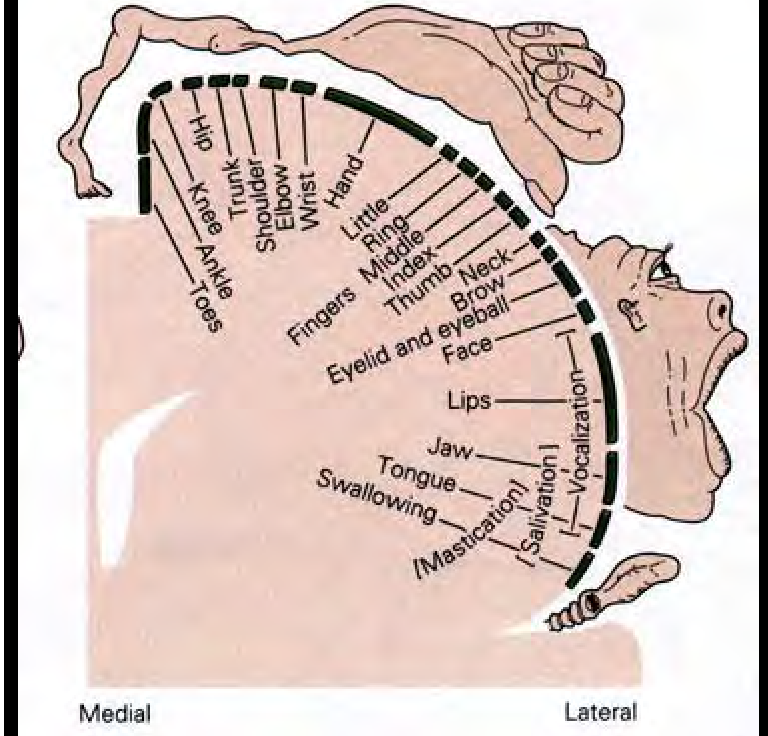


Figure F-3: Motor and Somatosensory Cortex





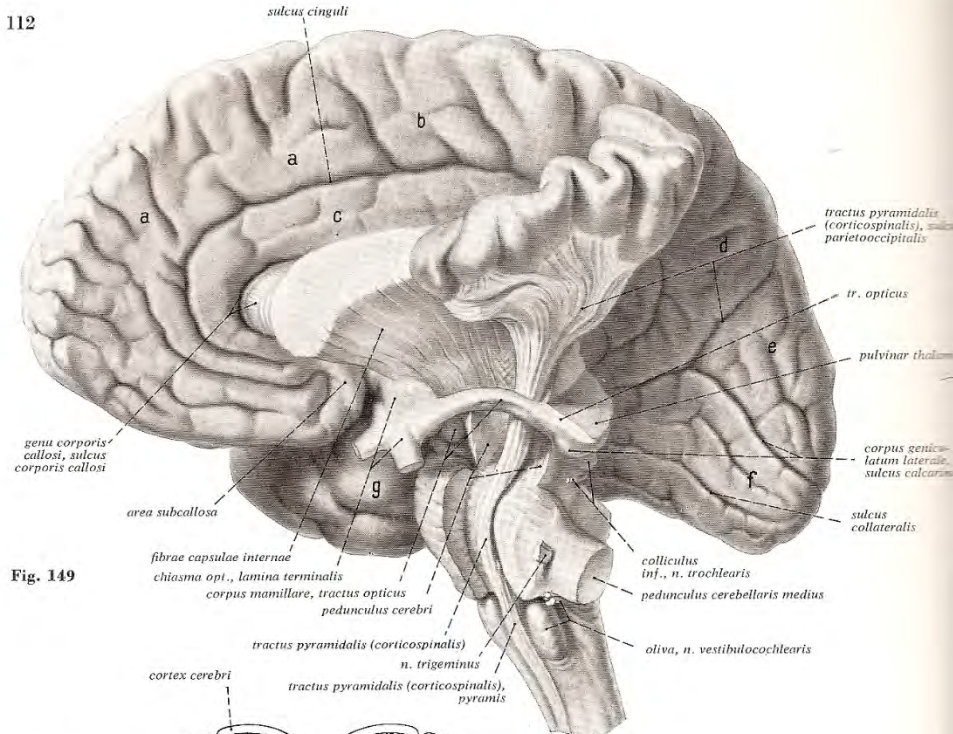


Fig. 149

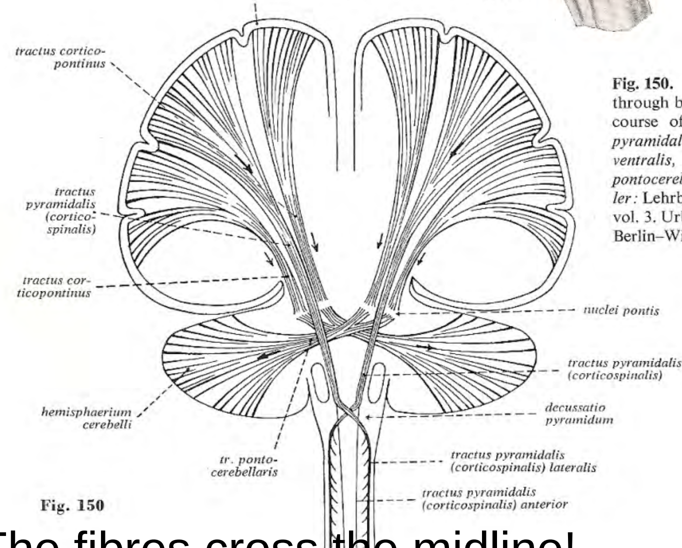


Fig. 150

Fig. 150. Diagram of a frontal section through brain and spinal cord showing the course of centrifugal pathways. *Tractus pyramidalis [corticospinalis]* lateralis et ventralis, tractus corticopontini, tractus pontocerebellares* (from *Benninghoff/Goerttler:* Lehrbuch der Anatomie des Menschen. vol. 3. Urban & Schwarzenberg, München–Berlin–Wien 1967).

NB! The fibres cross the midline!

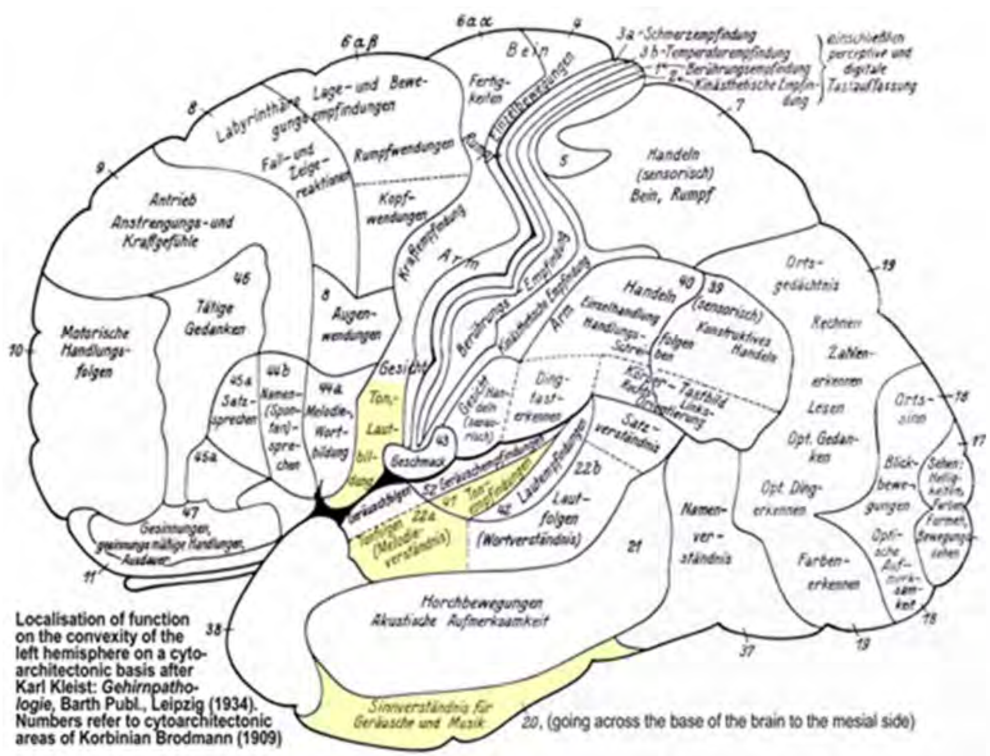
Karl Kleist (1879–1960)

German neurologist and psychiatrist

Localization of function in the cerebral cortex of man included mapping of cortical functions on brain maps.

The work is based on several hundred cases of shot wounded patients of World War I, whose function-deficits Kleist deliberately studied and described in detail during their lifetime.

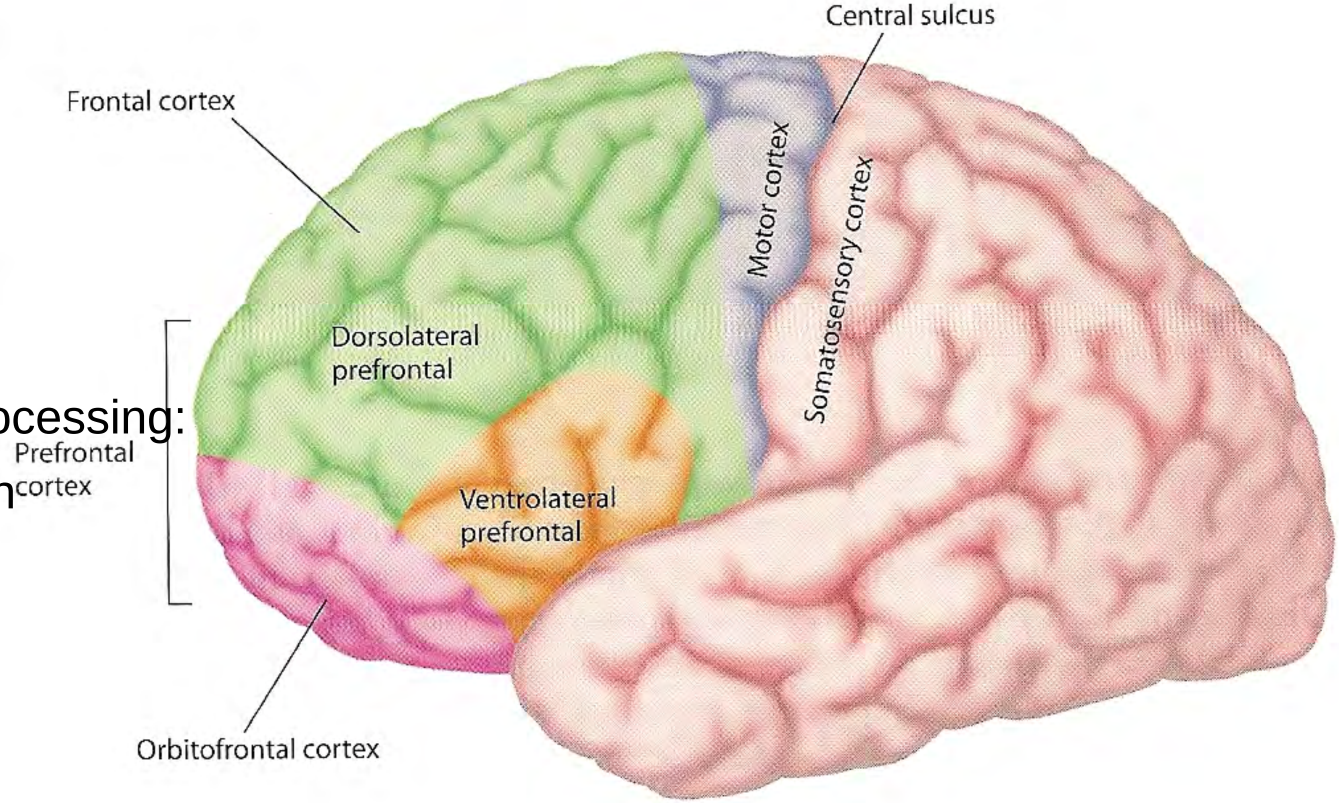
Later on by means of brain *autopsy* he documented the lesion and was, thus, able to localize brain function in each single case doing this also on cytoarchitectonical grounds.

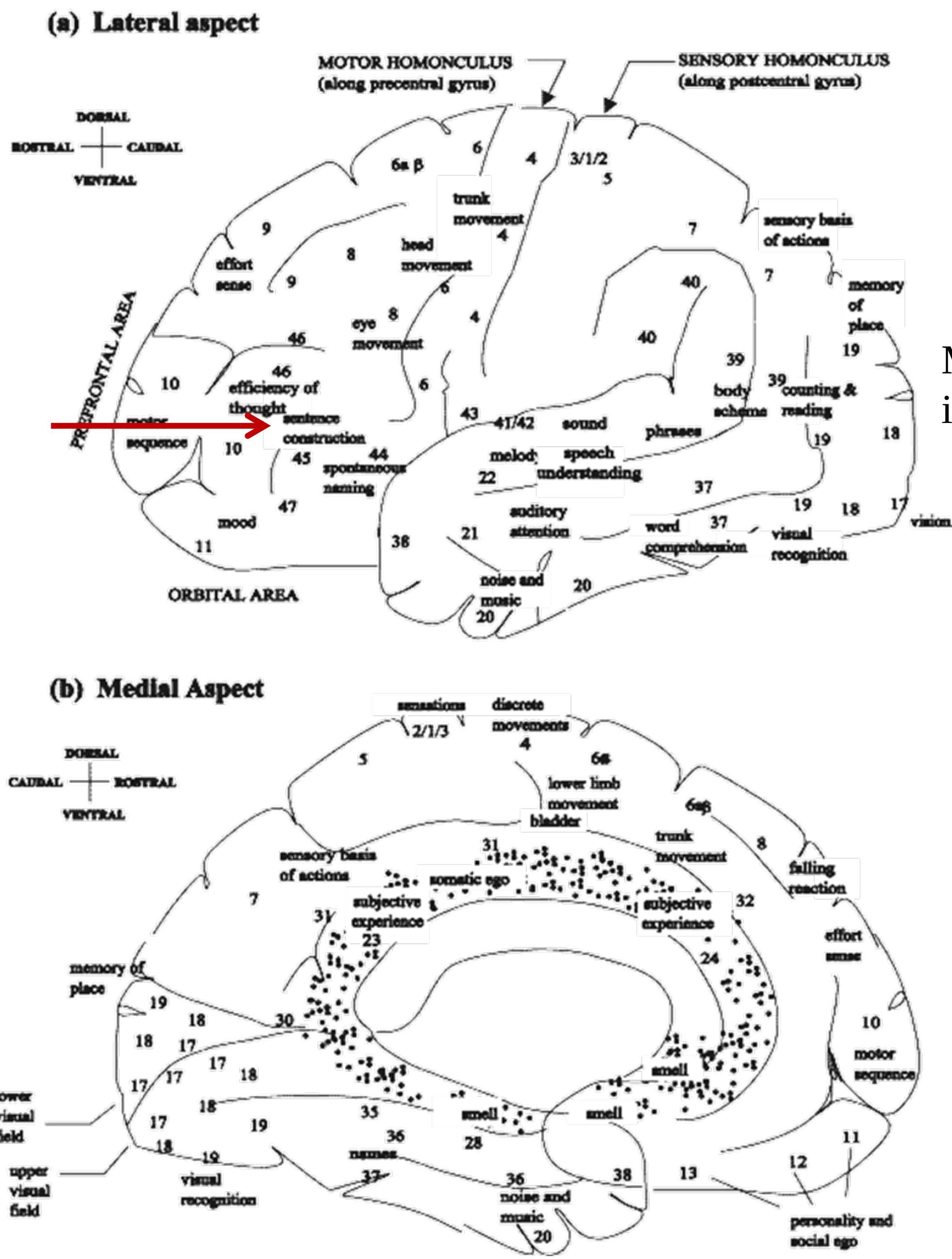


Localisation of function on the convexity of the left hemisphere on a cyto-architectonic basis after Karl Kleist: *Gehirnpathologie*, Barth Publ., Leipzig (1934). Numbers refer to cytoarchitectonic areas of Korbinian Brodmann (1909)

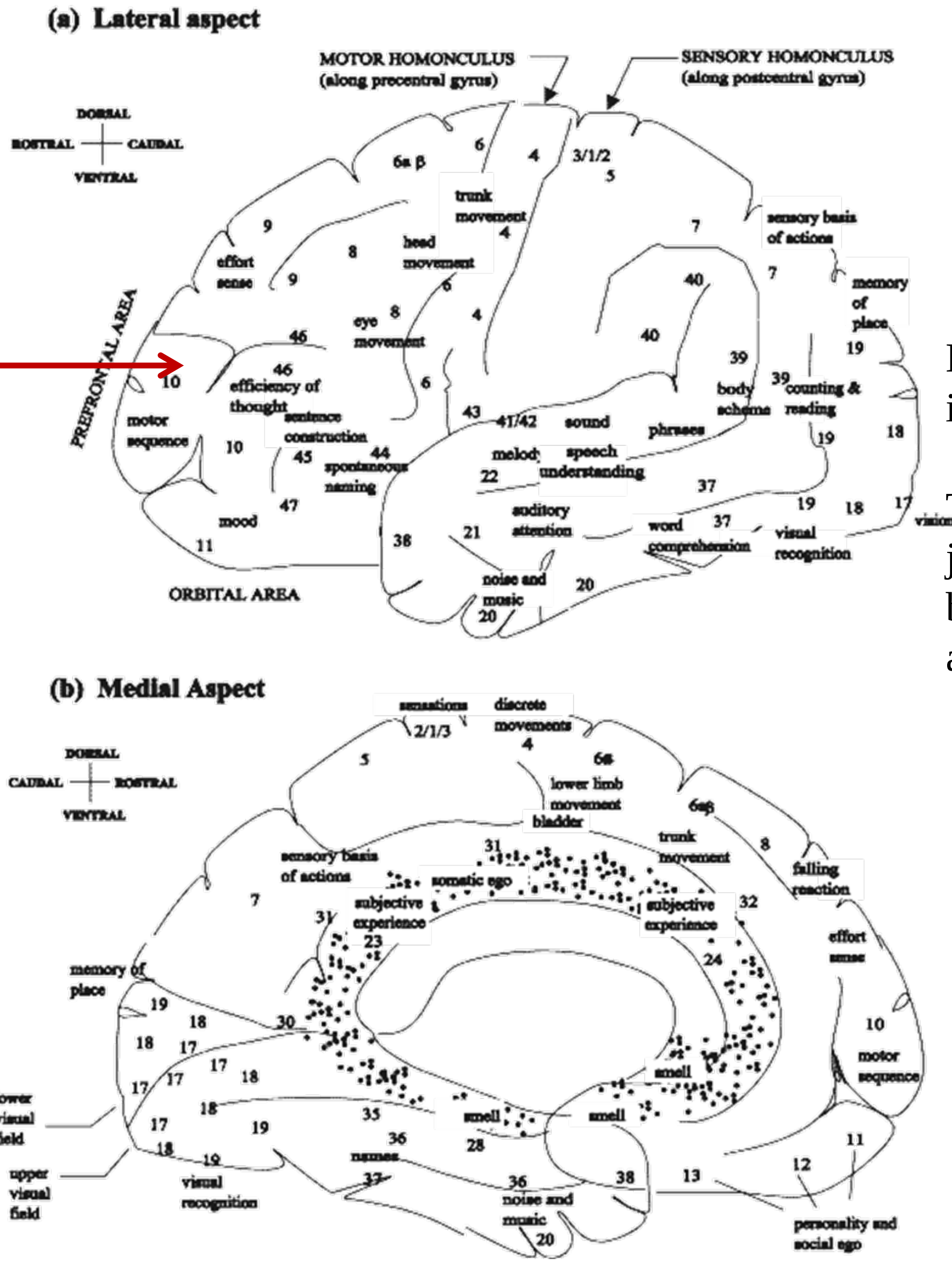
Figure 3.13 Divisions of the frontal cortex. The frontal lobe contains both motor and higher order association areas. For example, the prefrontal cortex is involved in executive functions, memory, and other processes.

Complex cognitive processing:
planning anf execution





Mind that Kleist's "efficiency of thought" is localised in the prefrontal cortex, Brodman area 10.



Mind that Kleist's efficiency of thought is localised in the prefrontal cortex, Brodman area 10.

The medial part of BA 10 is activated if we make judgments about what is morally good, what function best in social settings, as well as when we make aesthetic judgments.

ELSEVIER

NeuroImage

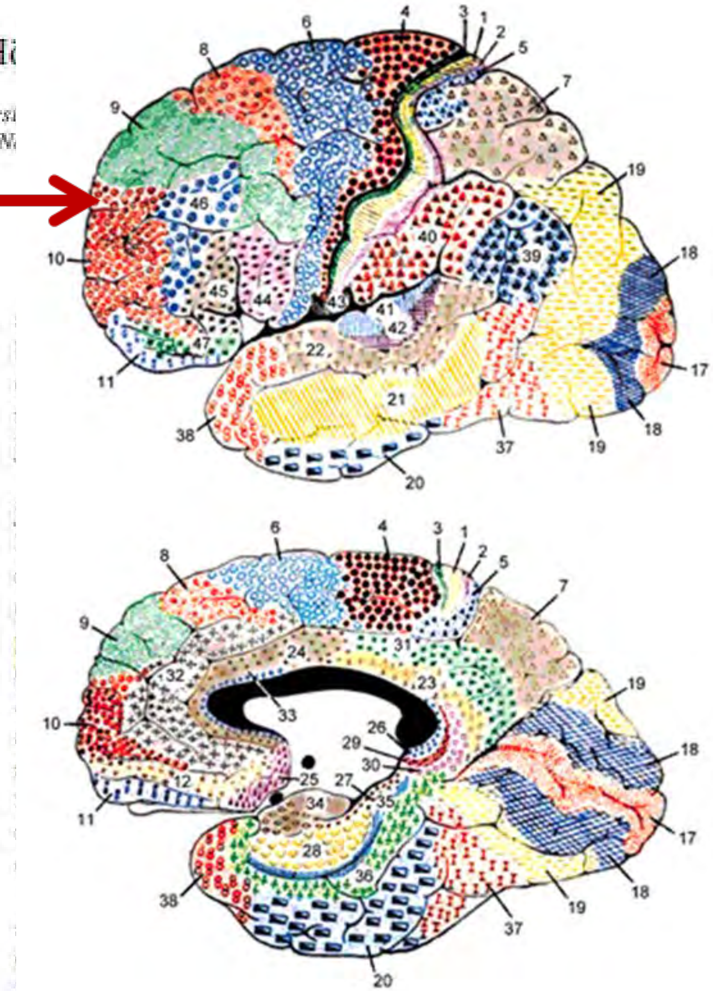
www.elsevier.com/locate/ynimg
NeuroImage 29 (2006) 276 – 285

Brain correlates of aesthetic judgment of beauty

Thomas Jacobsen,[a,*] Ricarda I. Schubotz,[b] Lea H

[a] *BioCog-Cognitive and Biological Psychology, Institute of Psychology I, Universi*
[b] *Max Planck Institute of Human Cognitive and Brain Sciences, Department of N*

Received 19 April 2005; revised 9 June 2005; accepted 6 July 2005
Available online 8 August 2005



Functional MRI was used to investigate the neural correlates of aesthetic judgments of beauty of geometrical shapes. Participants performed evaluative aesthetic judgments (beautiful or not?) and descriptive symmetry judgments (symmetric or not?) on the same stimulus material. Symmetry was employed because aesthetic judgments are known to be often guided by criteria of symmetry. Novel, abstract graphic patterns were presented to minimize influences of attitudes or memory-related processes and to test effects of stimulus symmetry and complexity. Behavioral results confirmed the influence of stimulus symmetry and complexity on aesthetic judgments. Direct contrasts showed specific activations for aesthetic judgments in the frontomedian cortex (BA 9/10), bilateral prefrontal BA 45/47, and posterior cingulate, left temporal pole, and the temporoparietal junction. In contrast, symmetry judgments elicited specific activations in parietal and premotor areas subserving spatial processing. Interestingly, beautiful judgments enhanced BOLD signals not only in the frontomedian cortex, but also in the left intraparietal sulcus of the symmetry network. Moreover, stimulus complexity caused differential effects for each of the two judgment types. Findings indicate aesthetic judgments of beauty to rely on a network partially overlapping with that underlying evaluative judgments on social and moral cues and substantiate the significance of symmetry and complexity for our judgment of beauty.

judgments that could not be based on attitudes (Petty et al., 1997)

ELSEVIER

NeuroImage

www.elsevier.com/locate/ynimg
NeuroImage 29 (2006) 276 – 285

Brain correlates of aesthetic judgment of beauty

Thomas Jacobsen,[a,*] Ricarda I. Schubotz,[b] Lea Höfel,[a] and D. Yves v. Cramon[b]

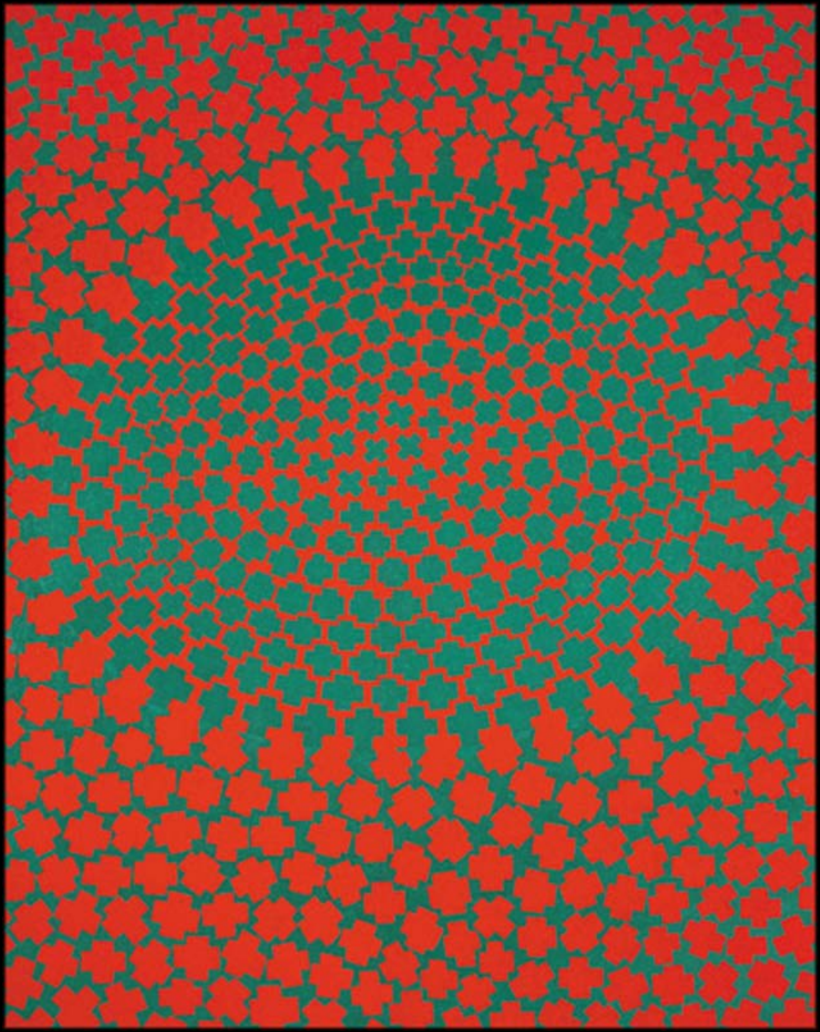
[a]BioCog-Cognitive and Biological Psychology, Institute of Psychology I, University of Leipzig, Seeburgstrasse 14-20, 04103 Leipzig, Germany
[b]Max Planck Institute of Human Cognitive and Brain Sciences, Department of Neurology, Leipzig, Germany

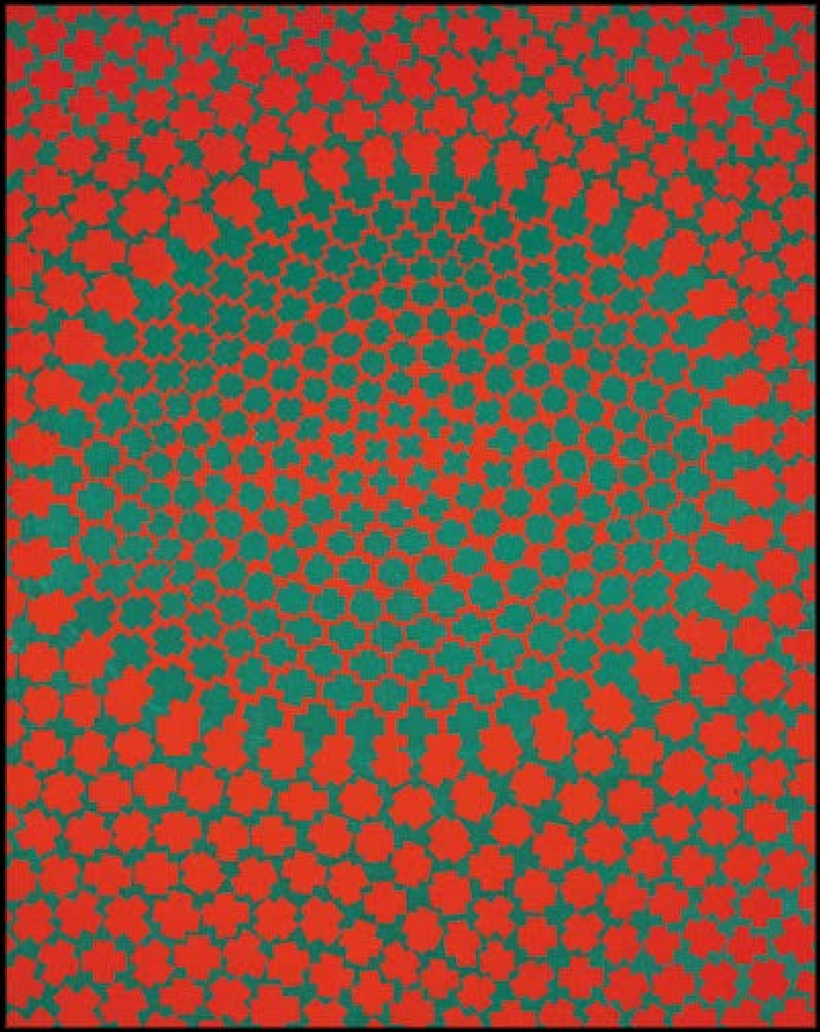
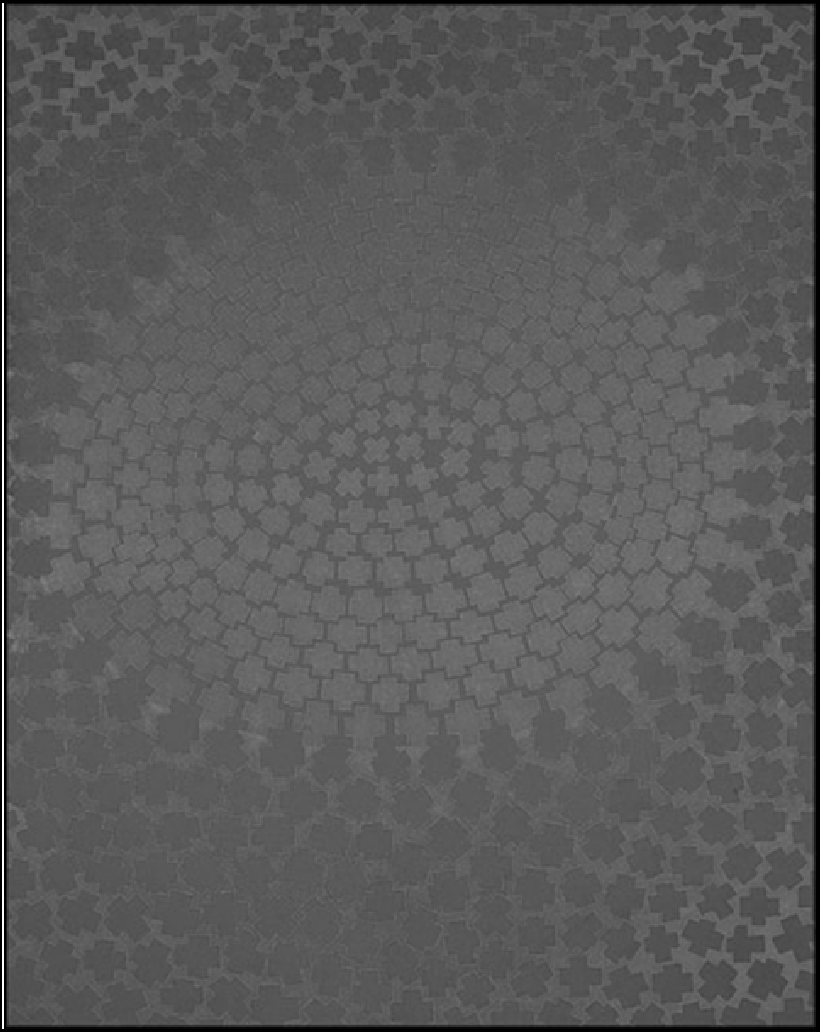
Conclusion

The present study shows, for the first time, that aesthetic judgments of beauty trigger activation in a brain network that generally underlies evaluative judgments, and hence share neural substrate with, e.g., social and moral judgments. Since judgments of beauty often base on the analysis of stimulus symmetry, a descriptive symmetry judgment was employed for comparison. The differential patterns of metabolism demonstrate that brain activations during aesthetic judgment cannot be reduced to an assessment of symmetry but are actually due to a particular mode of judgment.

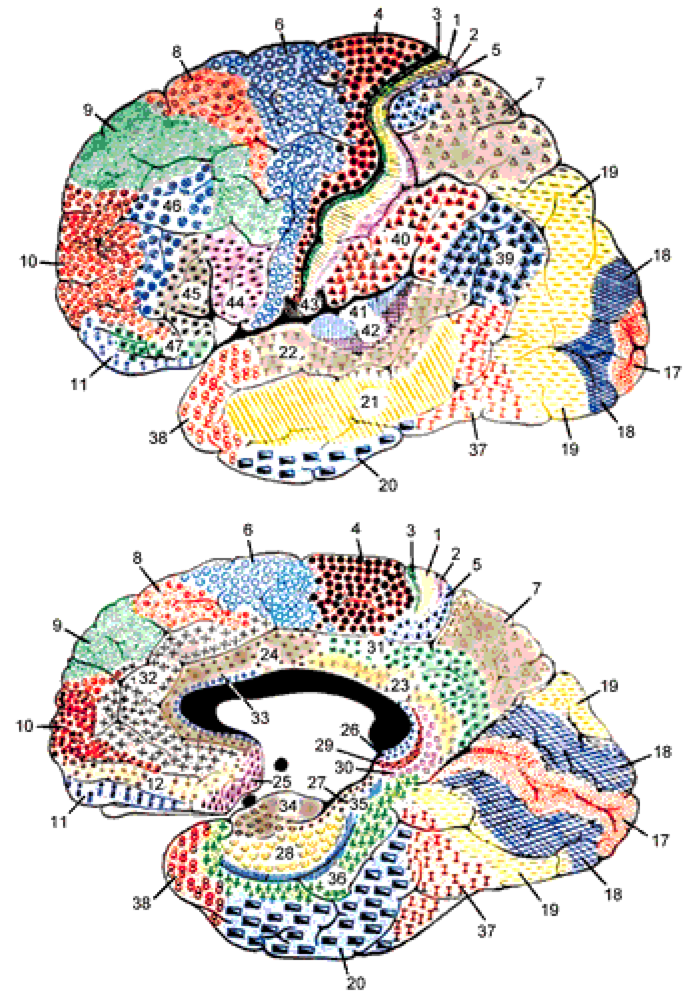
68. Roman copy of the head of Praxiteles' Aphrodite of Knidos, marble. Height approx. 10″.

Visual processes

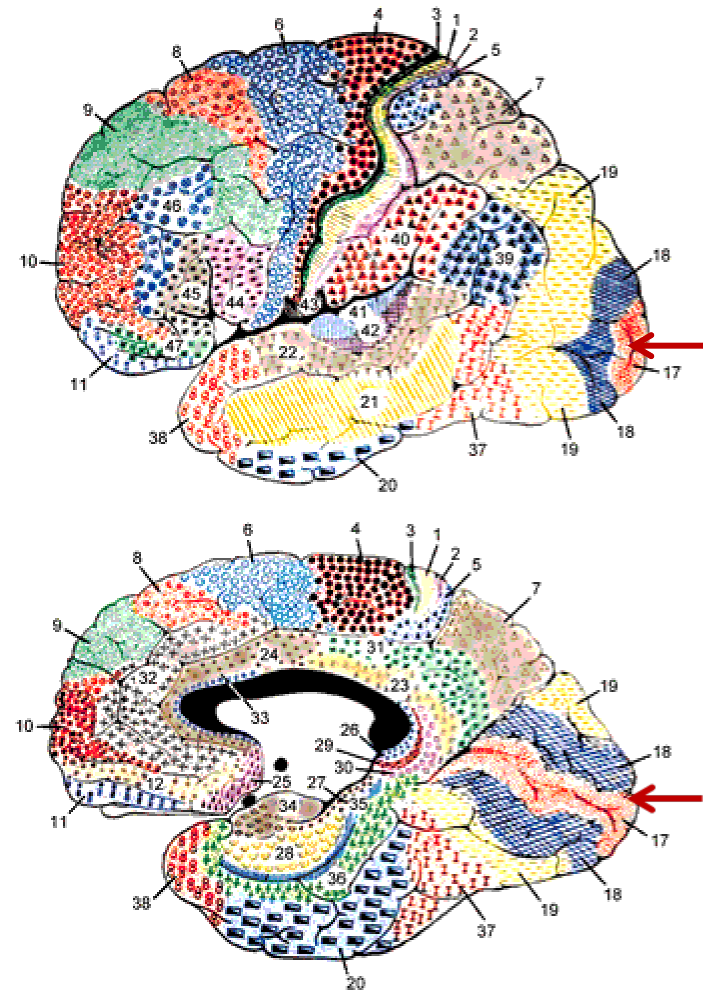


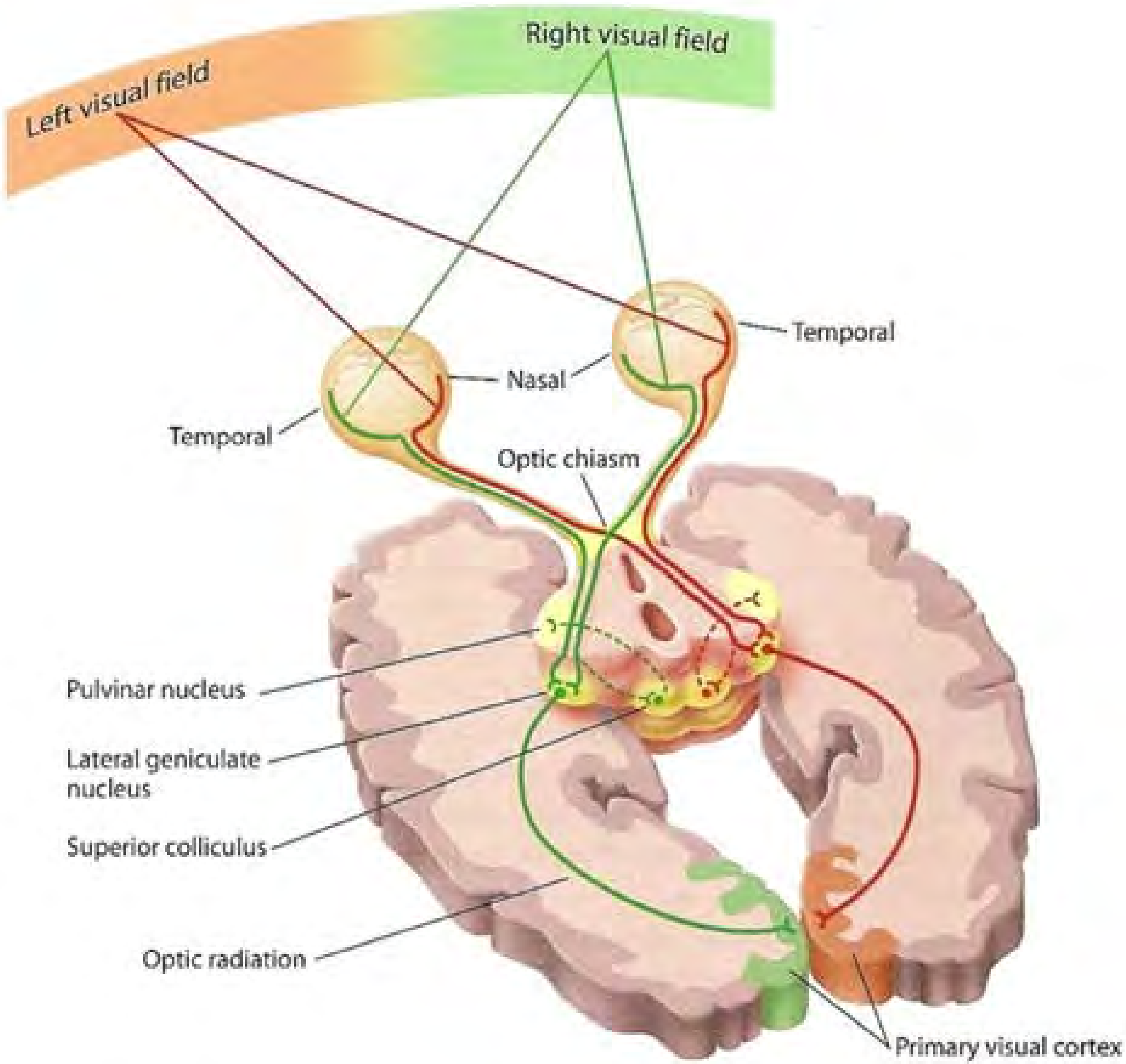



Korbinian Brodman's (1909-1960)
cytoarchitectonic map of the brain



Korbinian Brodman's (1909-1960) cytoarchitectonic map of the brain




Left visual field
Right visual field
Temporal
Nasal
Temporal
Optic chiasm
Pulvinar nucleus
Lateral geniculate nucleus
Superior colliculus
Optic radiation
Primary visual cortex

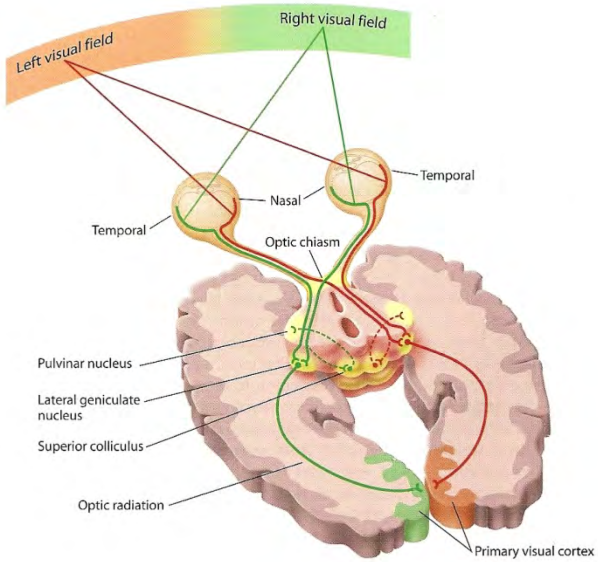
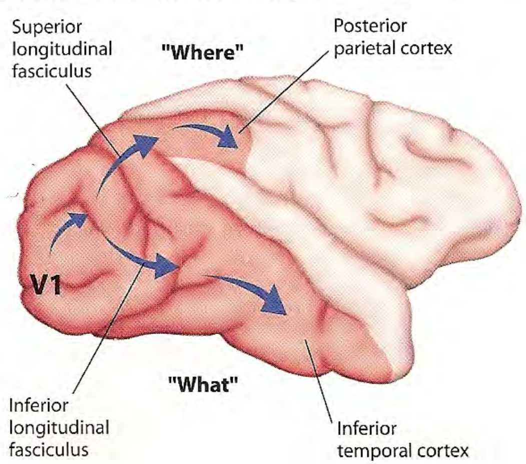
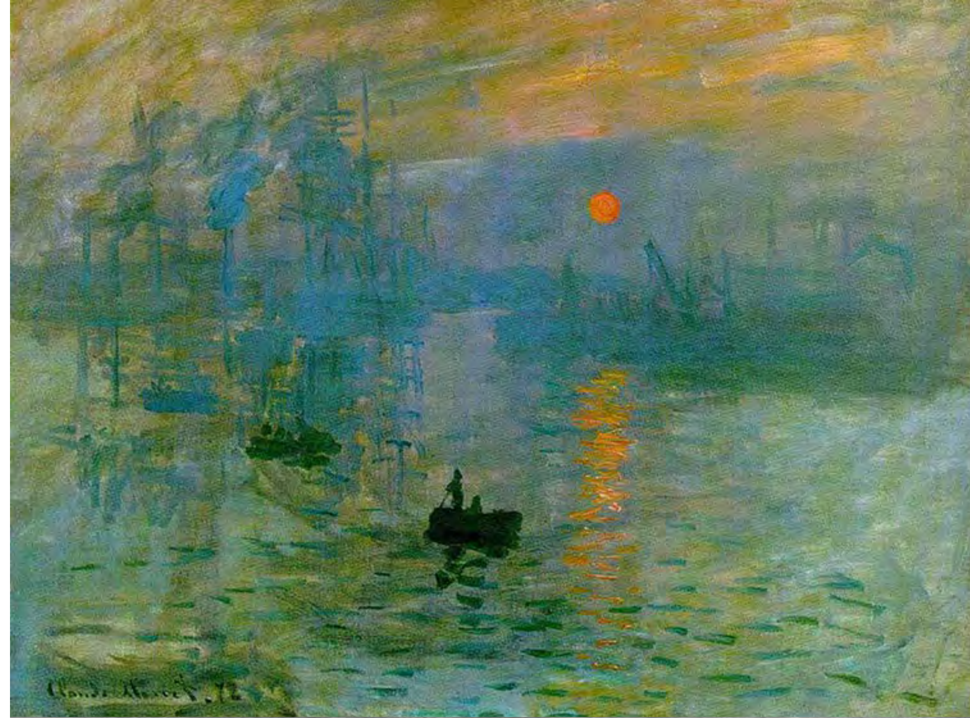
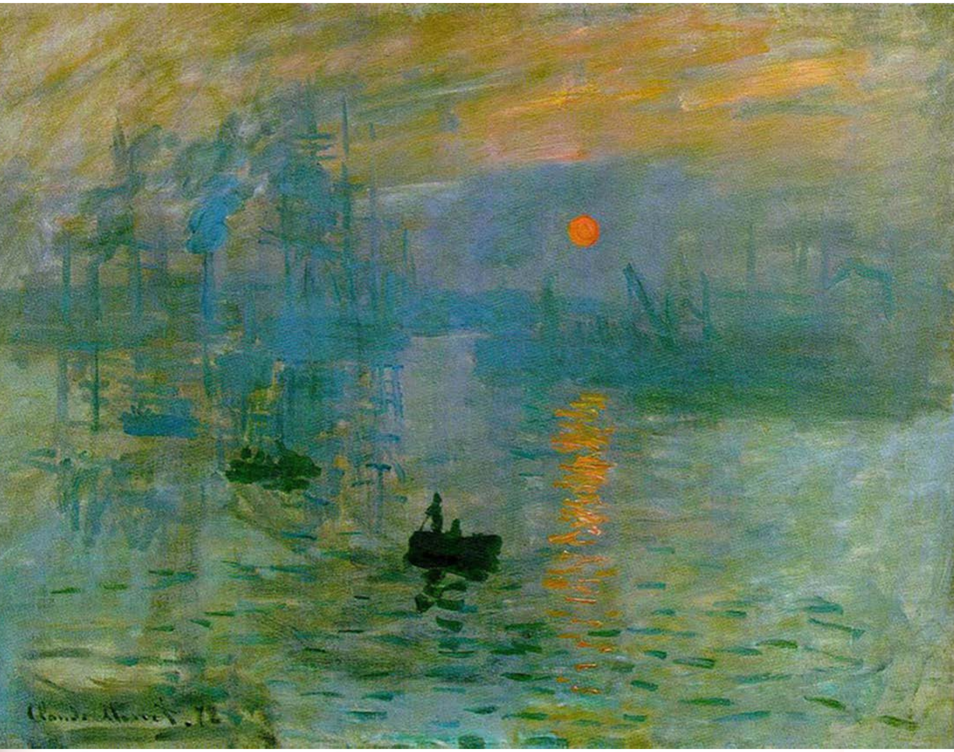
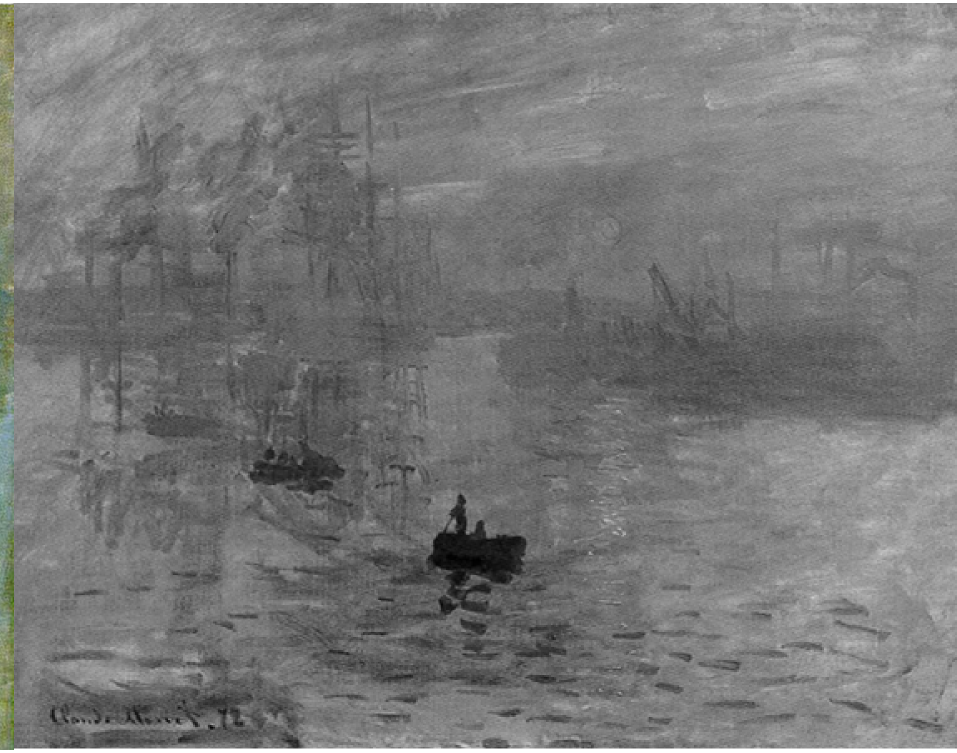


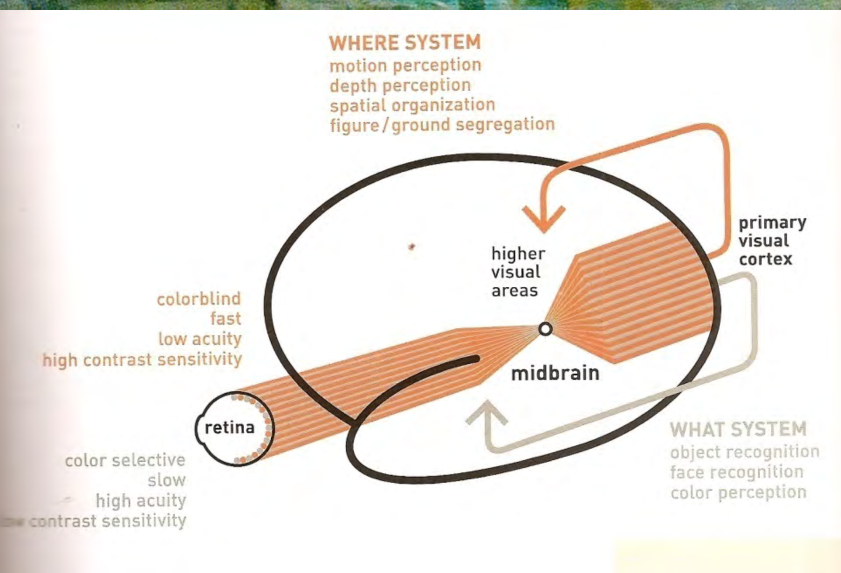
Figure 6.3 The "what" and "where" pathways for object recognition. The outputs from the primary visual cortex (V1) follow two general pathways: The superior longitudinal fasciculus includes axons terminating in the posterior parietal cortex, a region associated with identifying the location of the object ("where"). The inferior longitudinal fasciculus contains axons terminating in the inferotemporal cortex, a region implicated in object recognition ("what").









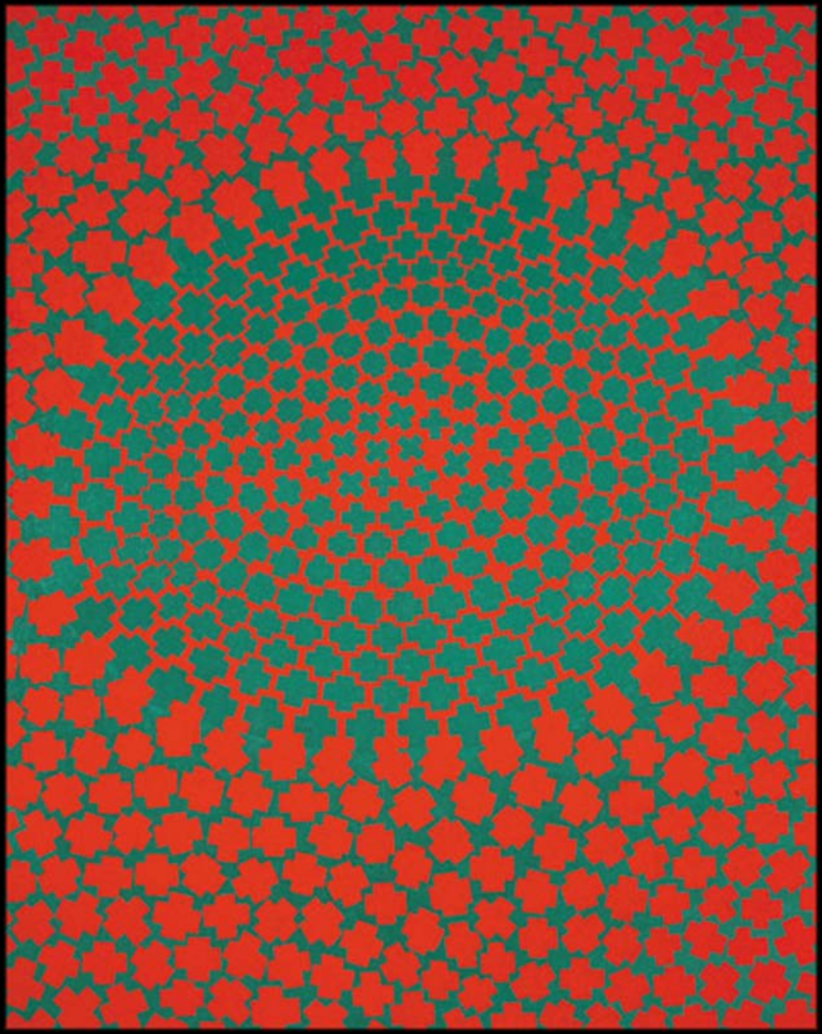


In the grayscale version of Monet's *Soleil levant* (1872) the intensely bright sun has almost completely dissappeared. Why? It is because the sun is isoluminant with the background colour. But why is the sun so intensely shimmering when we look at the original painting?

The reason is that there is two different systems leading from the primary visual cortex to higher visual areas of the brain. The «where system» which follows the *superior longitudinal fasciculus* is colour blind and only tuned to luminance contrasts.

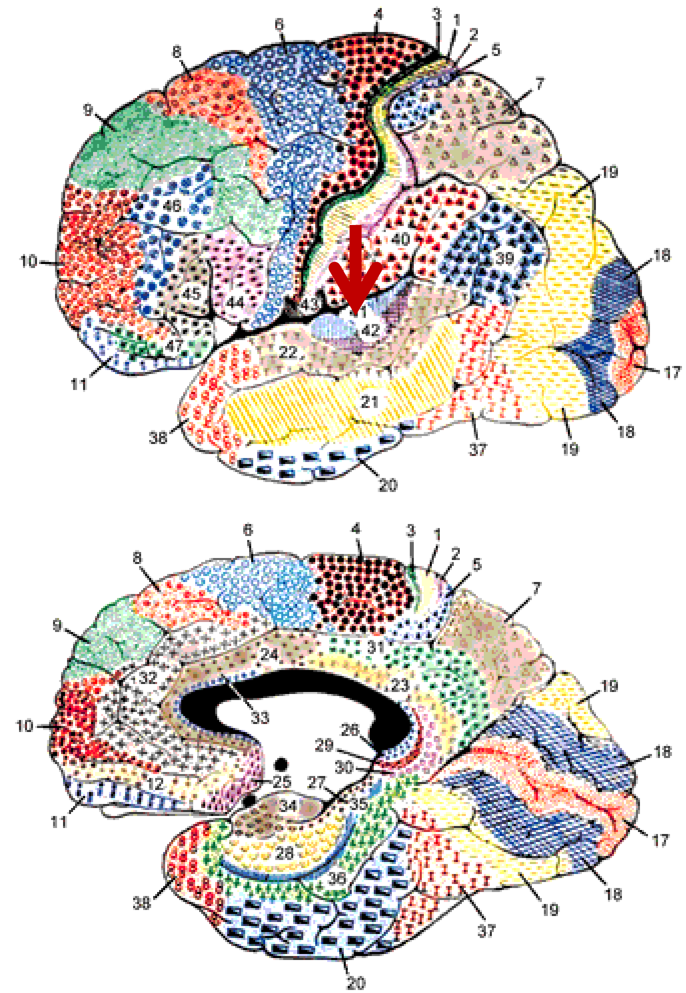
The ventral «what system» follows the *inferior longitudinal fasciculus*. It is colour sensitive, and recognises objects, faces etc. The colour sensitive «what» pathway recognizes the sun and its colour in Monet's painting. The «where» pathway is, however, blind for the isoluminant sun.

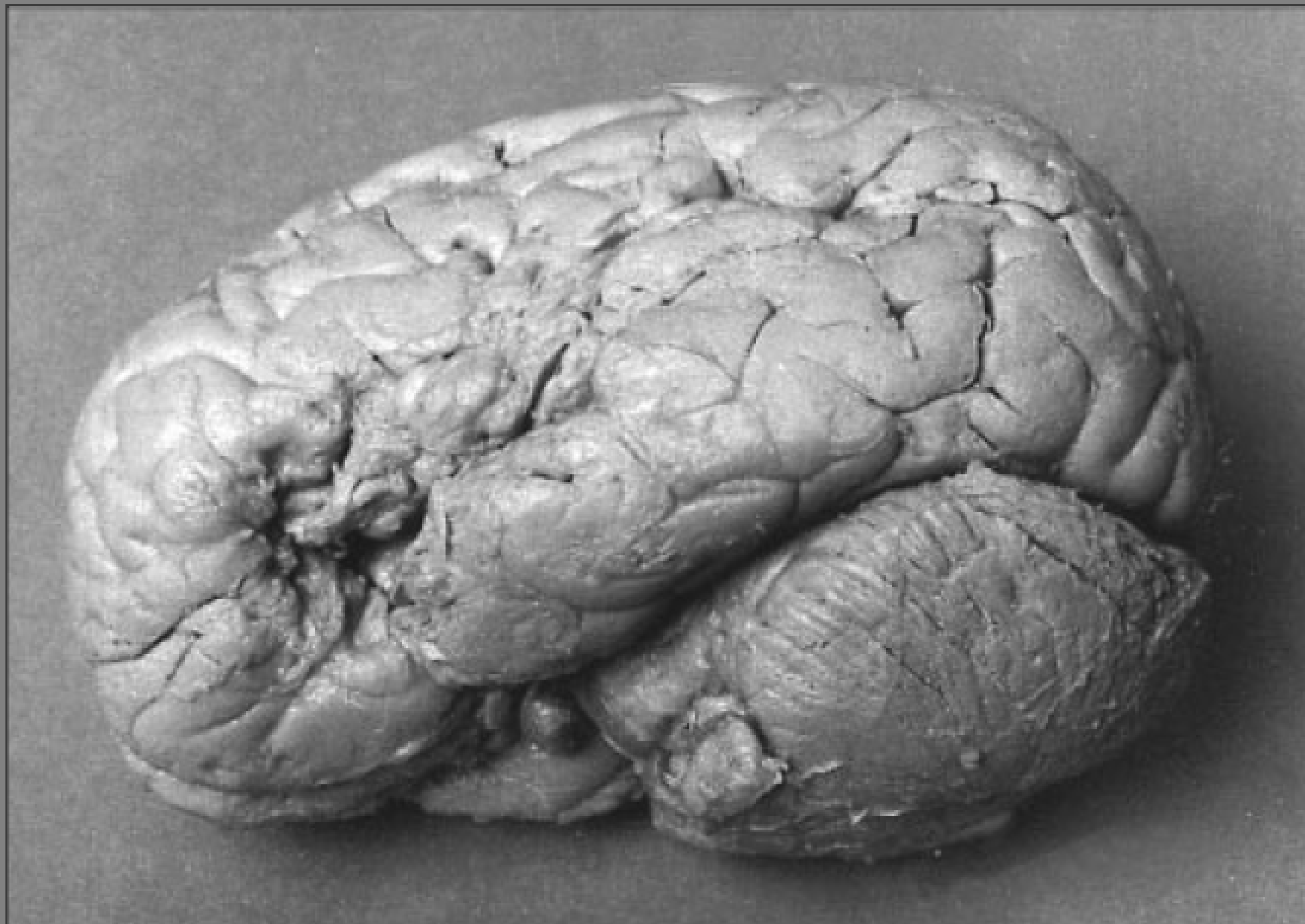
It becomes an oscillation between the «what» and the «where» system, which results in a shimmering of the isoluminant sun.

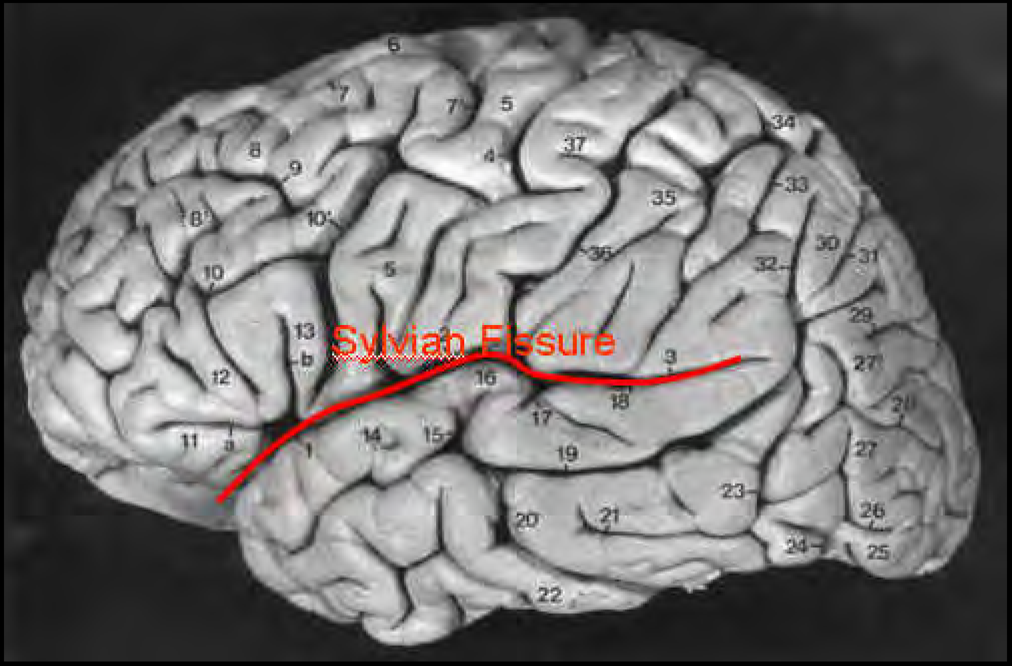


Hearing and word formation

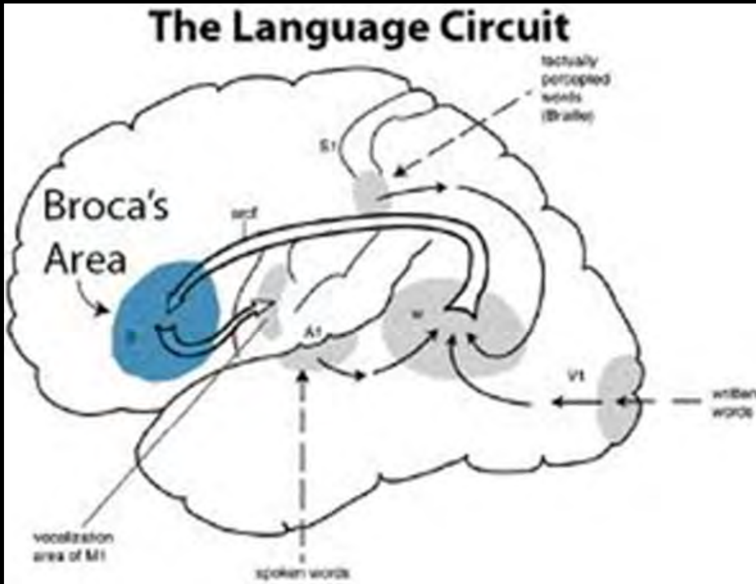
Korbinian Brodman's (1909-1960)
cytoarchitectonic map of the brain

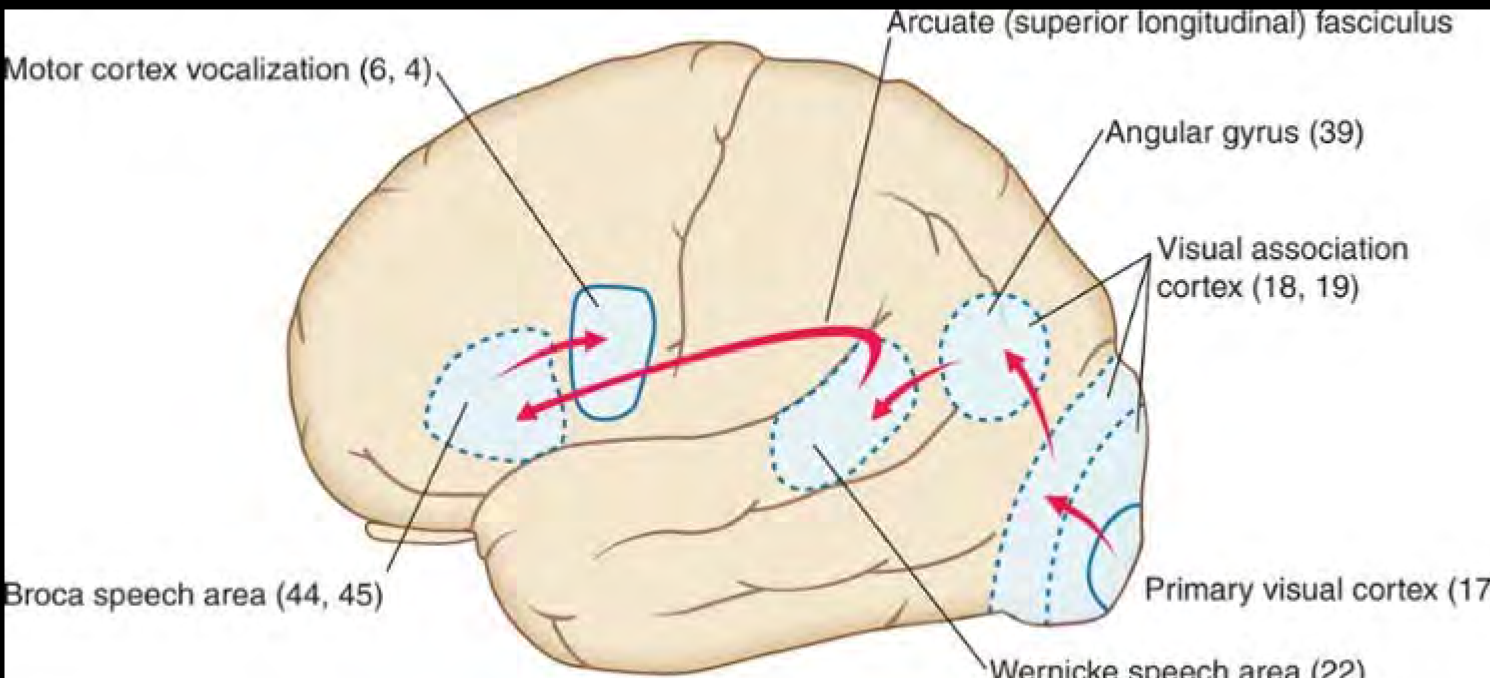


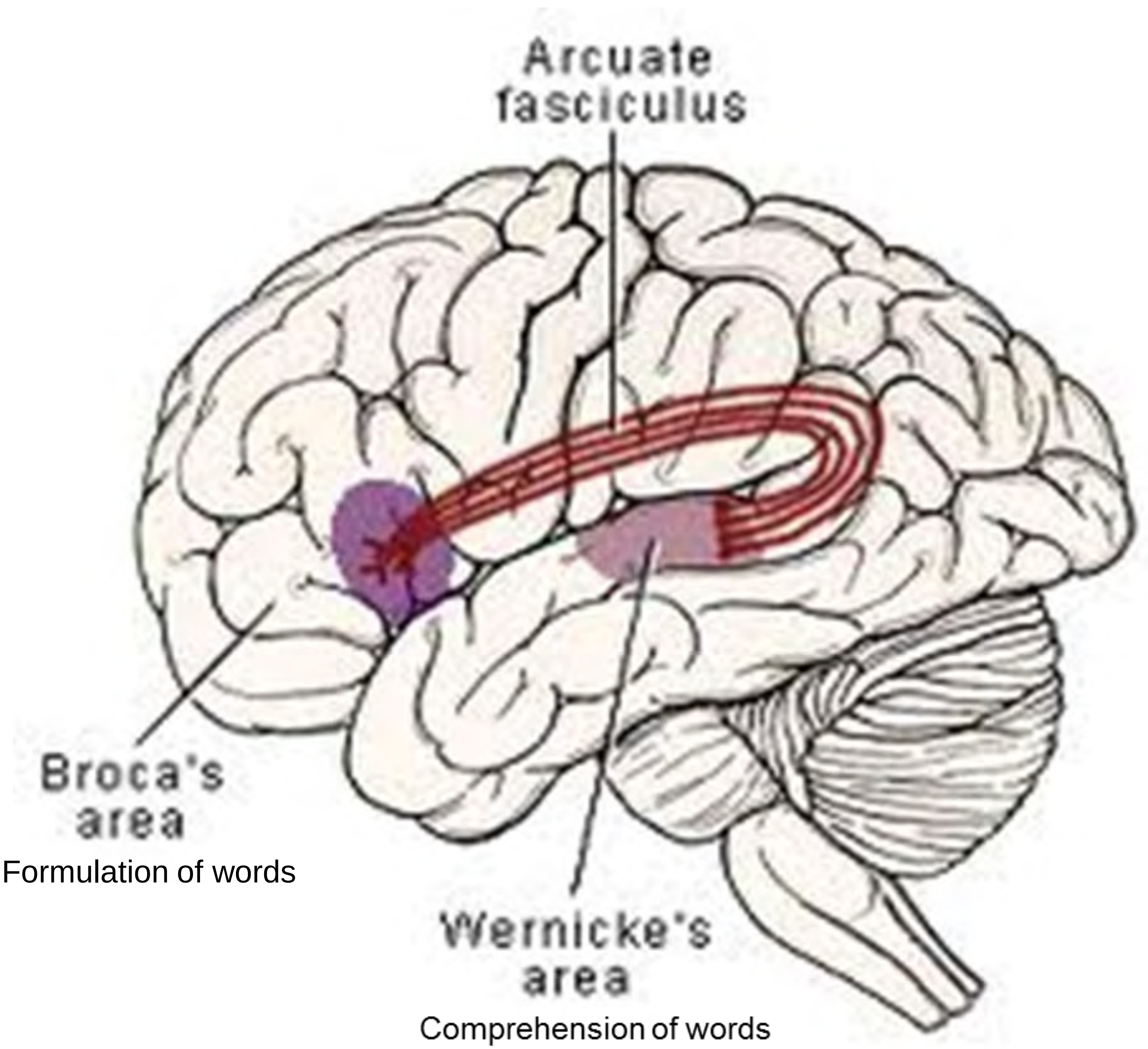


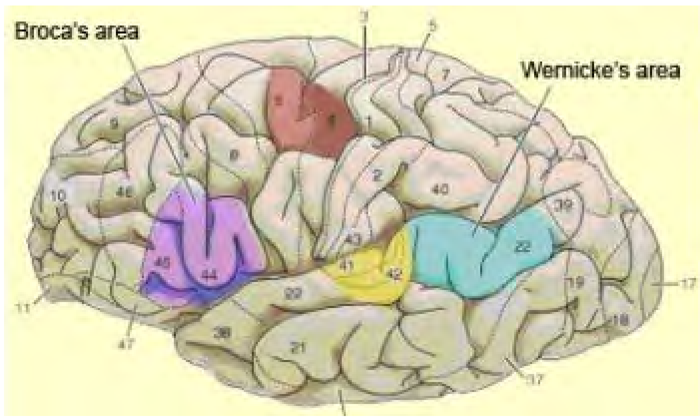


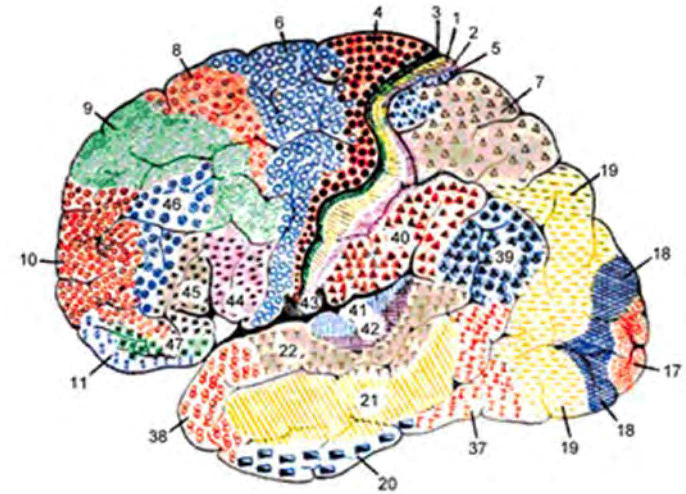
Sylvian Fissure
6
7
7'
5
34
37
8
9
4
33
35
8'
10'
30
31
36
5
32
10
29
13
b
3
27'
12
16
18
28
17
11
a
1
14
15
19
27
23
26
20
21
24
25
22

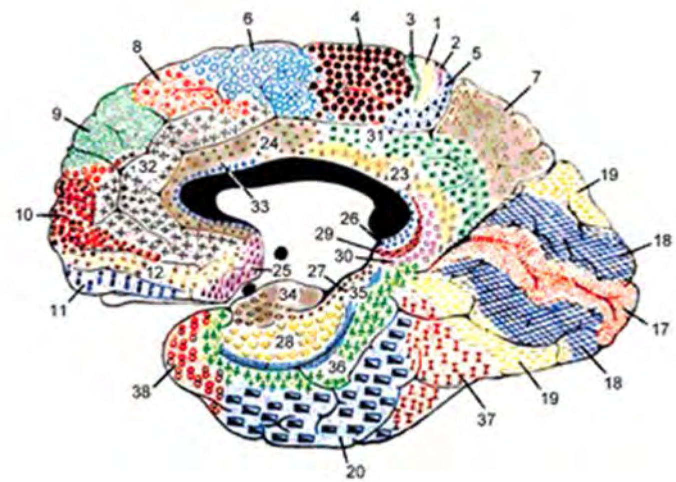

The Language Circuit
Broca's Area
S1
A1
V1
vocalization area of M1
spoken words

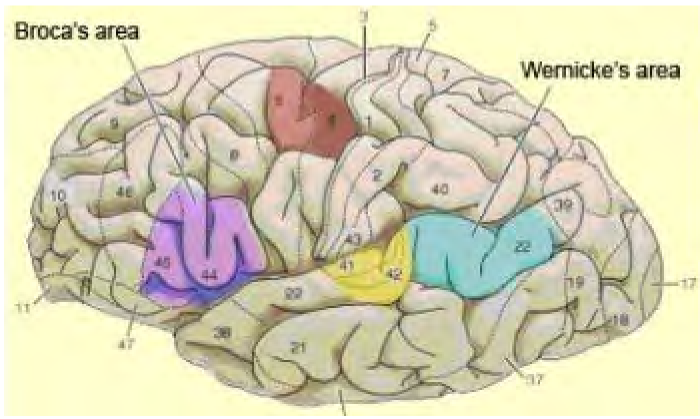

Arcuate (superior longitudinal) fasciculus
Motor cortex vocalization (6, 4)
Angular gyrus (39)
Visual association cortex (18, 19)
Broca speech area (44, 45)
Primary visual cortex (17)
Wernicke speech area (22)

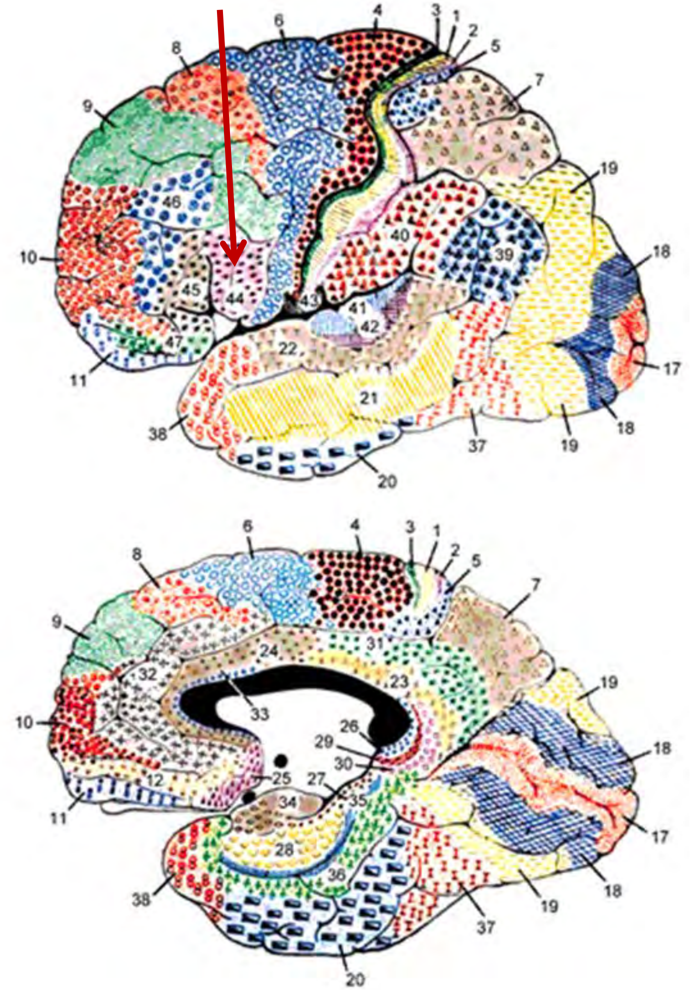

Arcuate fasciculus
Broca's area
Formulation of words
Wernicke's area
Comprehension of words

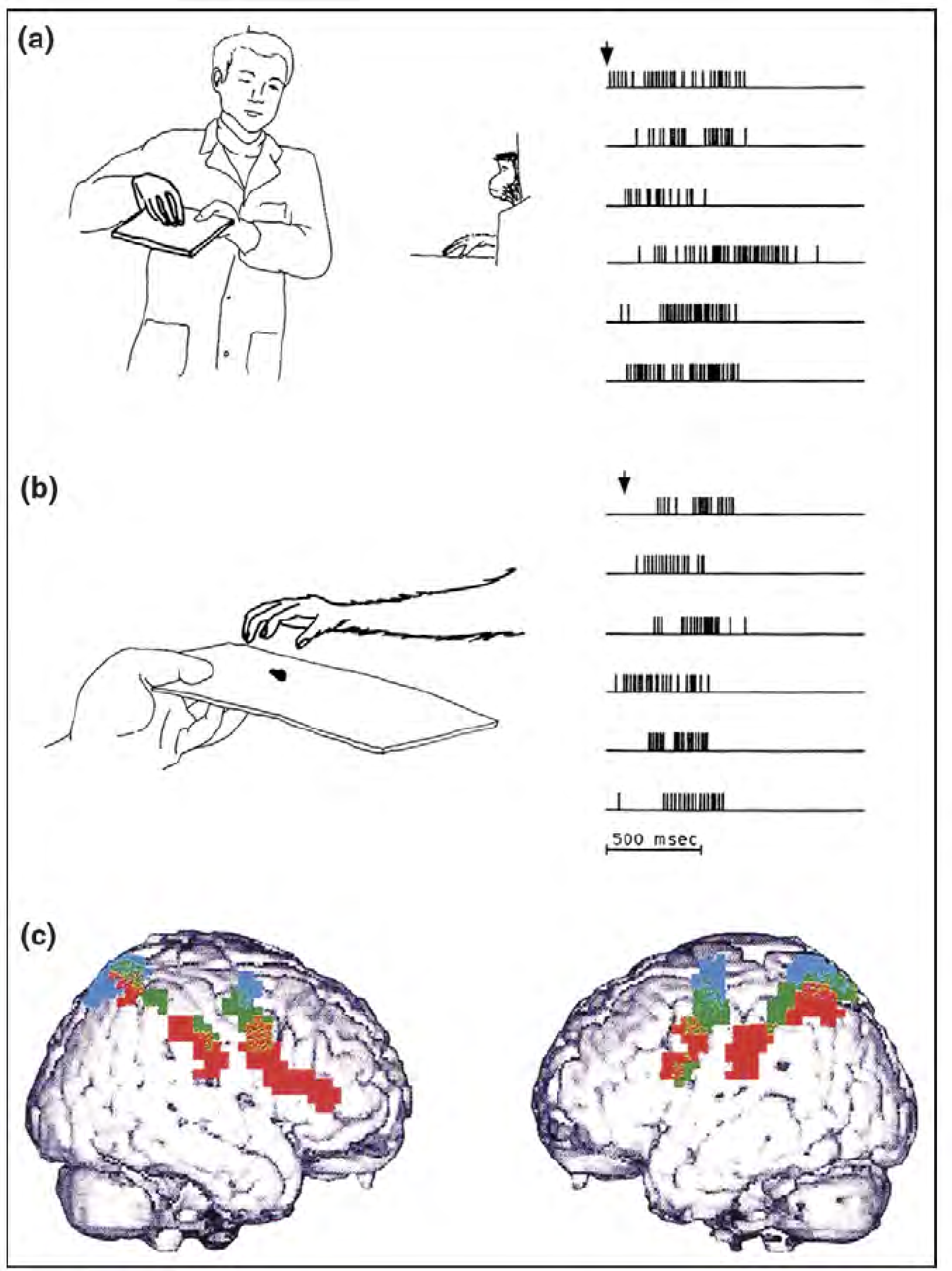

Broca's area
Wernicke's area
3
5
7
9
8
6
4
1
2
40
46
10
39
22
43
41
42
45
44
22
19
17
18
11
47
38
21
37


4
3
1
2
5
6
8
7
9
19
46
40
39
10
18
45
44
43
41
42
17
47
22
11
21
38
37
19
18
20


6
4
3
1
2
5
8
7
9
24
31
32
23
19
10
33
26
29
30
18
12
25
27
35
34
11
17
28
36
38
37
19
18
20


Broca's area
Wernicke's area
3
5
7
9
6
46
10
45
44
43
41
42
22
40
39
2
1
19
17
18
21
38
11
47
37


4
6
3
1
2
5
8
7
9
19
46
40
39
10
18
45
44
43
41
42
47
22
17
11
21
38
37
19
18
20
24
31
32
33
23
26
29
30
12
25
27
35
34
28
36



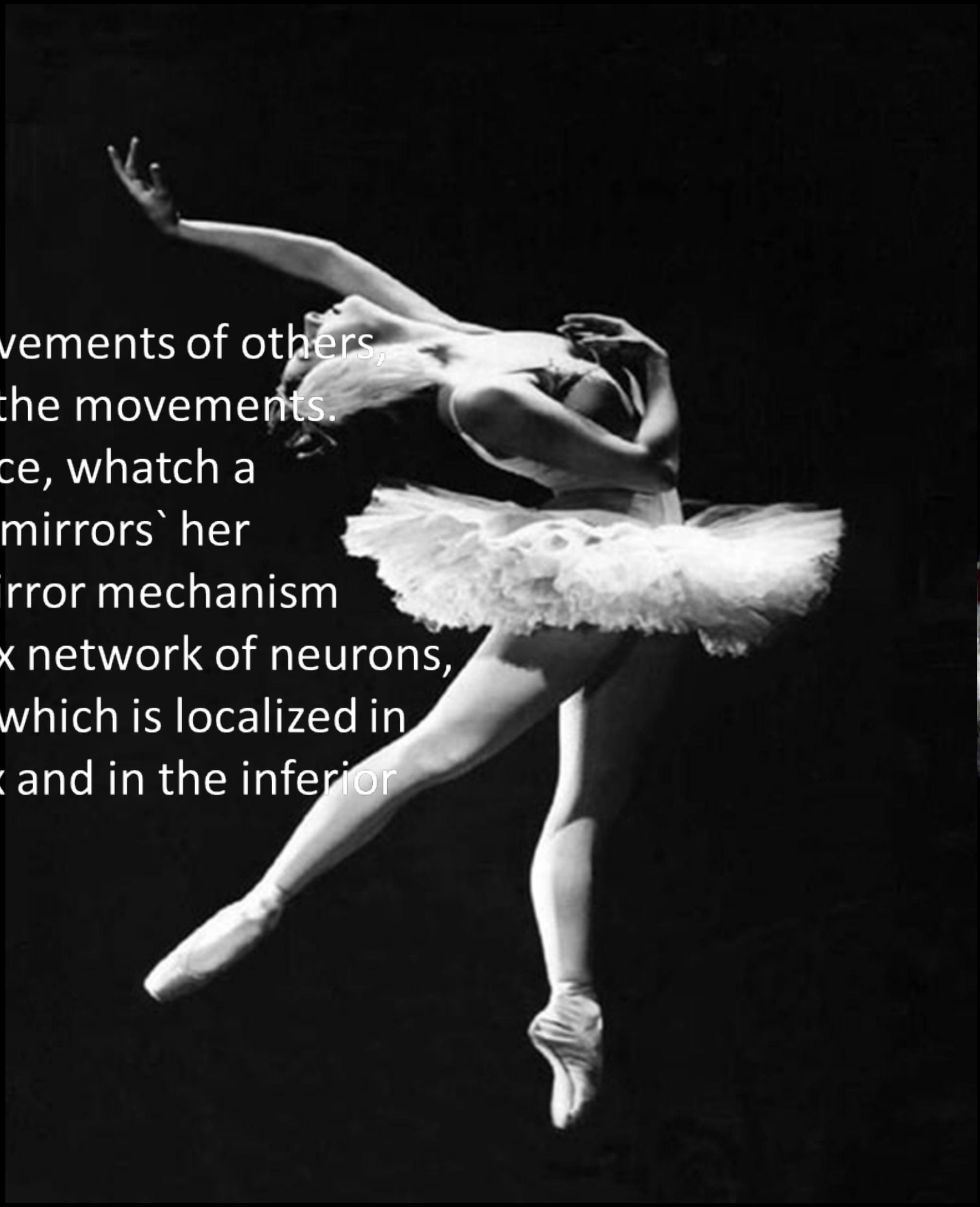
mirroring mechanisms

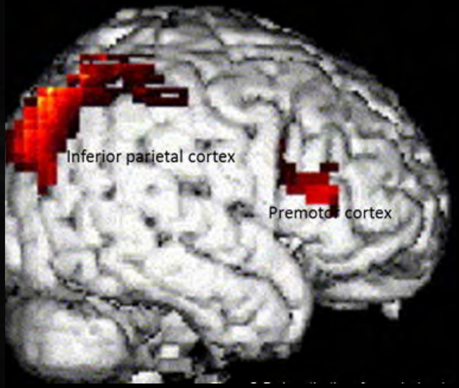
mirror neurons

embodied mechanisms

empathetic responses

When observing movements of others, our brain «mirrors» the movements. When we, for instance, whatch a ballerina, our brain ´mirrors` her movements. This mirror mechanism consists of a complex network of neurons, the mirror neurons, which is localized in the prefrontal cortex and in the inferior parietal cortex.





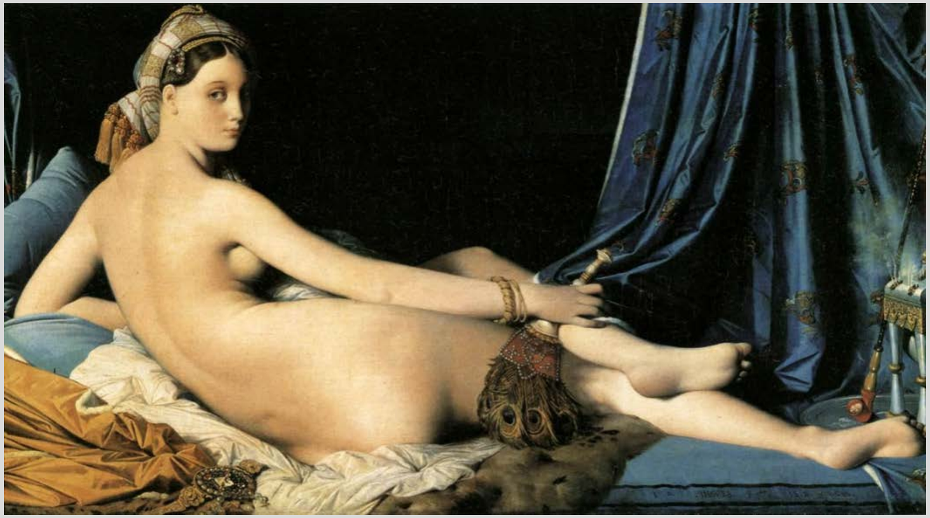
When we try to grasp a 3D form, there will be an activation of Brodmann area 7 in the parietal cortex. This means that when we look at sculptures, our parietal lobe tries to interpret its deapth for us, so that we can calculate how it is sculptured around, also at the side that is obscured by our present position.

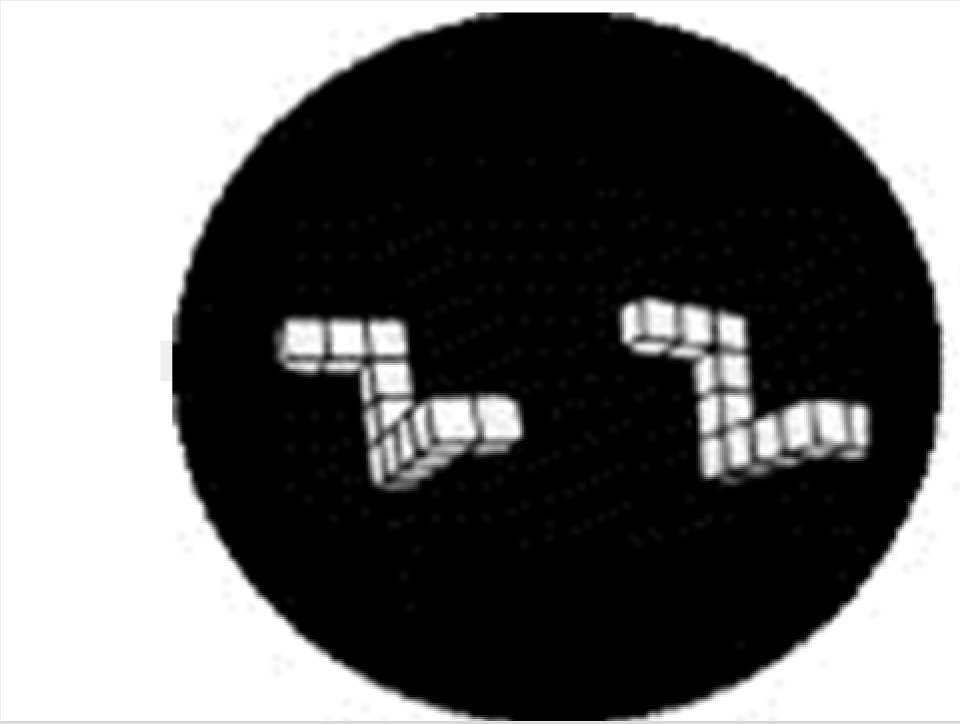
(4) NUDE:

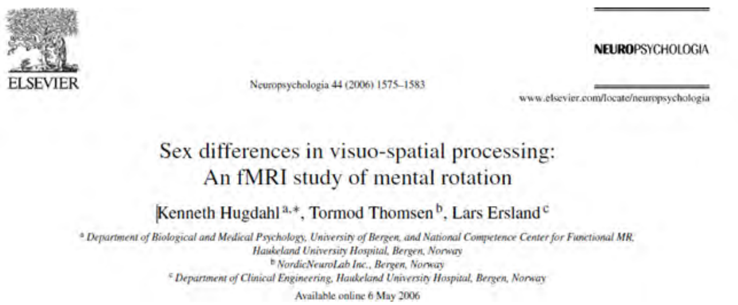
HARD — N25, N68

SOFT — N66, N67

In fact, this system also works when we look at paintings, particularly when the paintings have «soft edges», so that they are not clearly delineated. Our Brodmann area 7 in *parietal cortex* tells us how to recognize the three dimensional form in such more schetchy paintings.

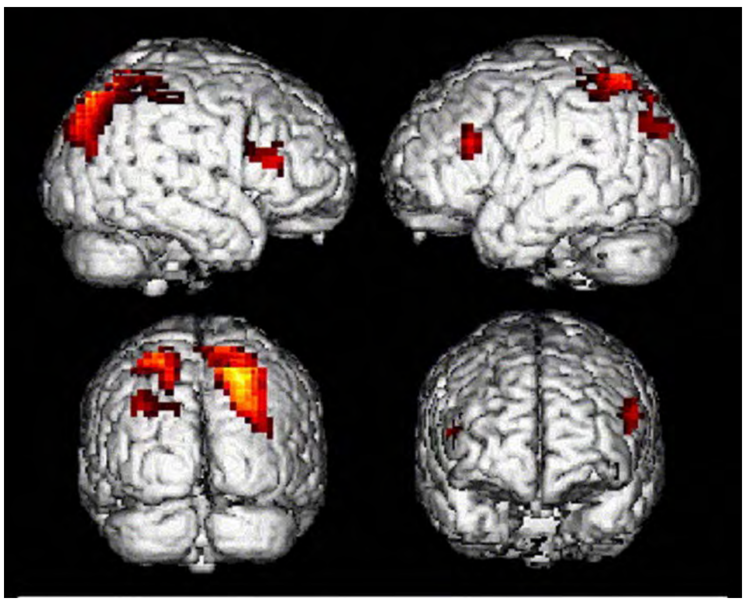





ELSEVIER
Neuropsychologia 44 (2006) 1575–1583
NEUROPSYCHOLOGIA
www.elsevier.com/locate/neuropsychologia

Sex differences in visuo-spatial processing:
An fMRI study of mental rotation

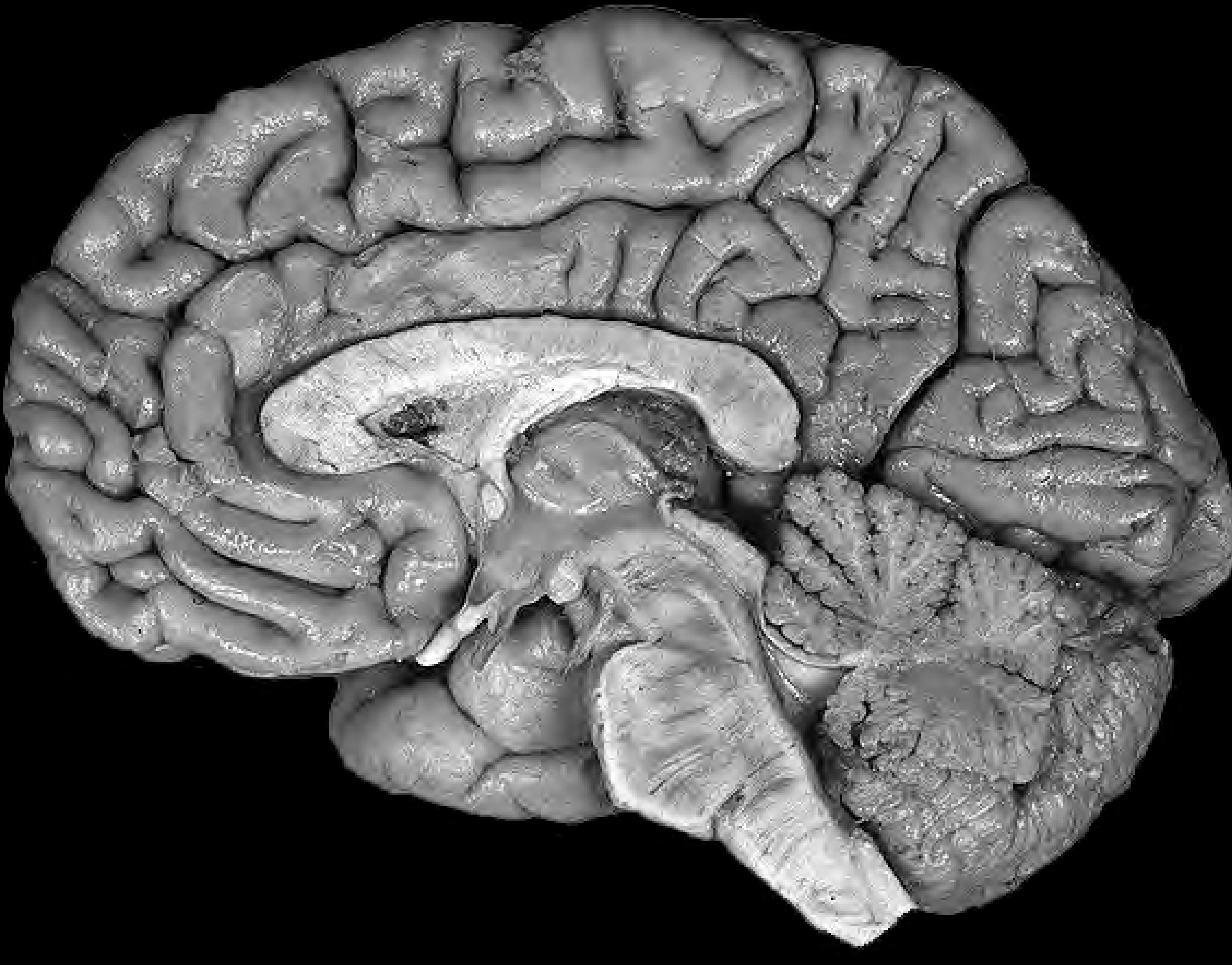
Kenneth Hugdahl[a,*], Tormod Thomsen[b], Lars Ersland[c]
[a] Department of Biological and Medical Psychology, University of Bergen, and National Competence Center for Functional MR, Haukeland University Hospital, Bergen, Norway
[b] NordicNeuroLab Inc., Bergen, Norway
[c] Department of Clinical Engineering, Haukeland University Hospital, Bergen, Norway
Available online 6 May 2006

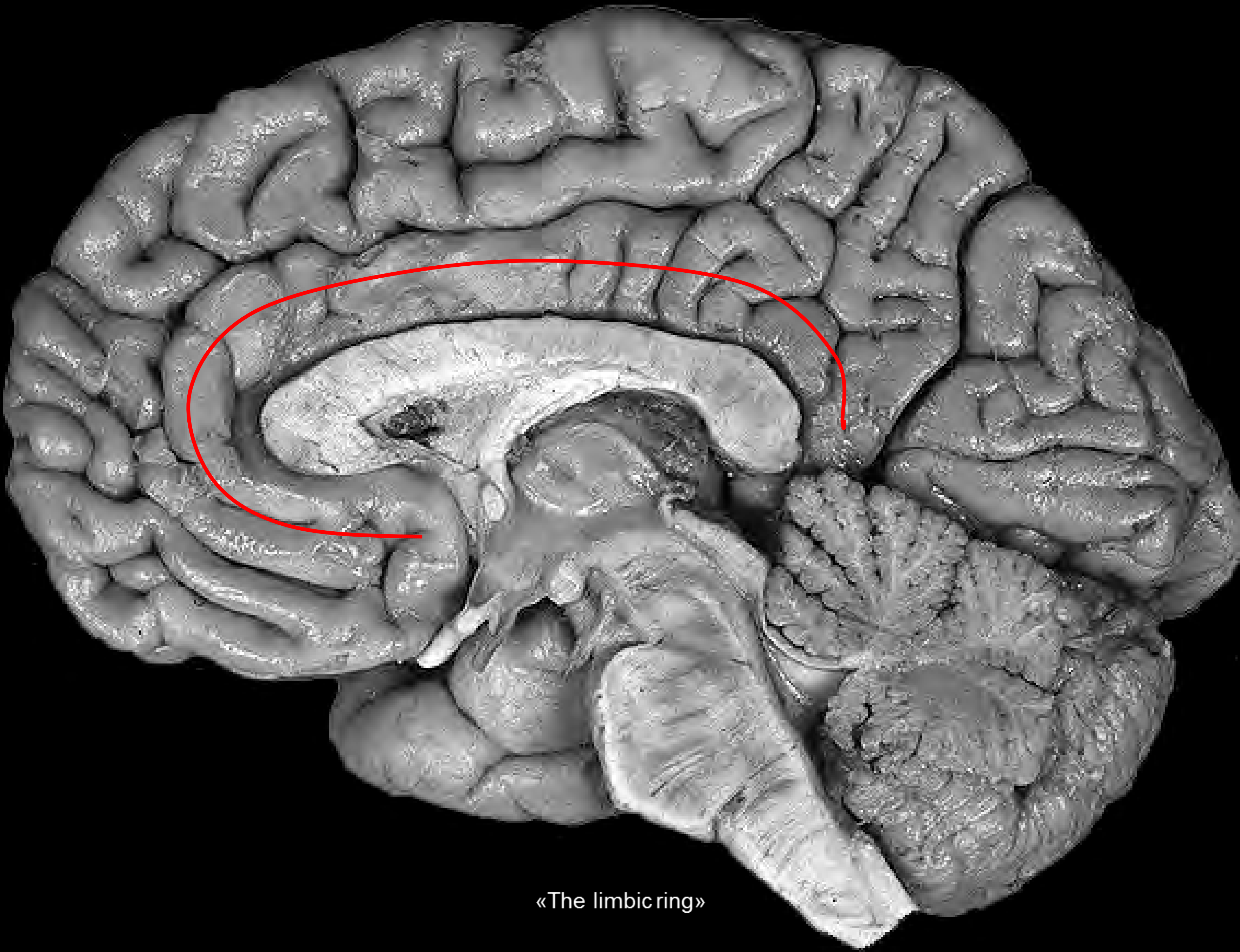


Experimentally, it has been proved that when we analyze a 3D form, comparing it with another 3D form, trying to find out whether the two forms are equual, a process called mental rotation, the foremost activation takes place in the parietal cortex, Brodmann area 7.

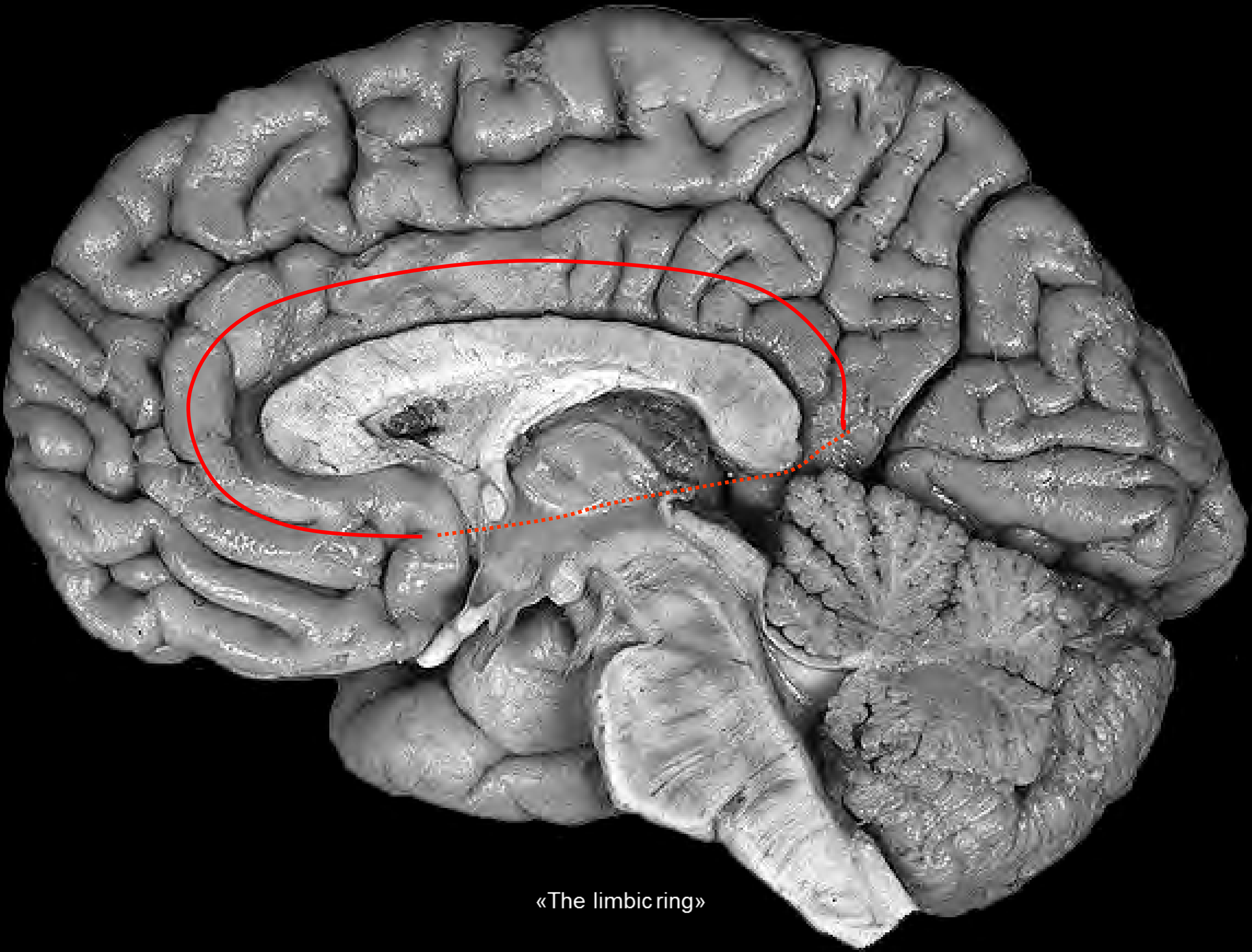
There are sex-differences here: men are usually more clever in mental rotation tasks than women. Women, on the other hand, are much more clever in a verbal description, telling how different items are located in relation to each other etc. The differences betwee sexes is usually explained according to the so called hunter gatherer hypothesis, where men were out in landscape, hunting, while women were home, gathering berrys, fruits, preparing food etc.

Emotions, the limbic system





«The limbic ring»



«The limbic ring»

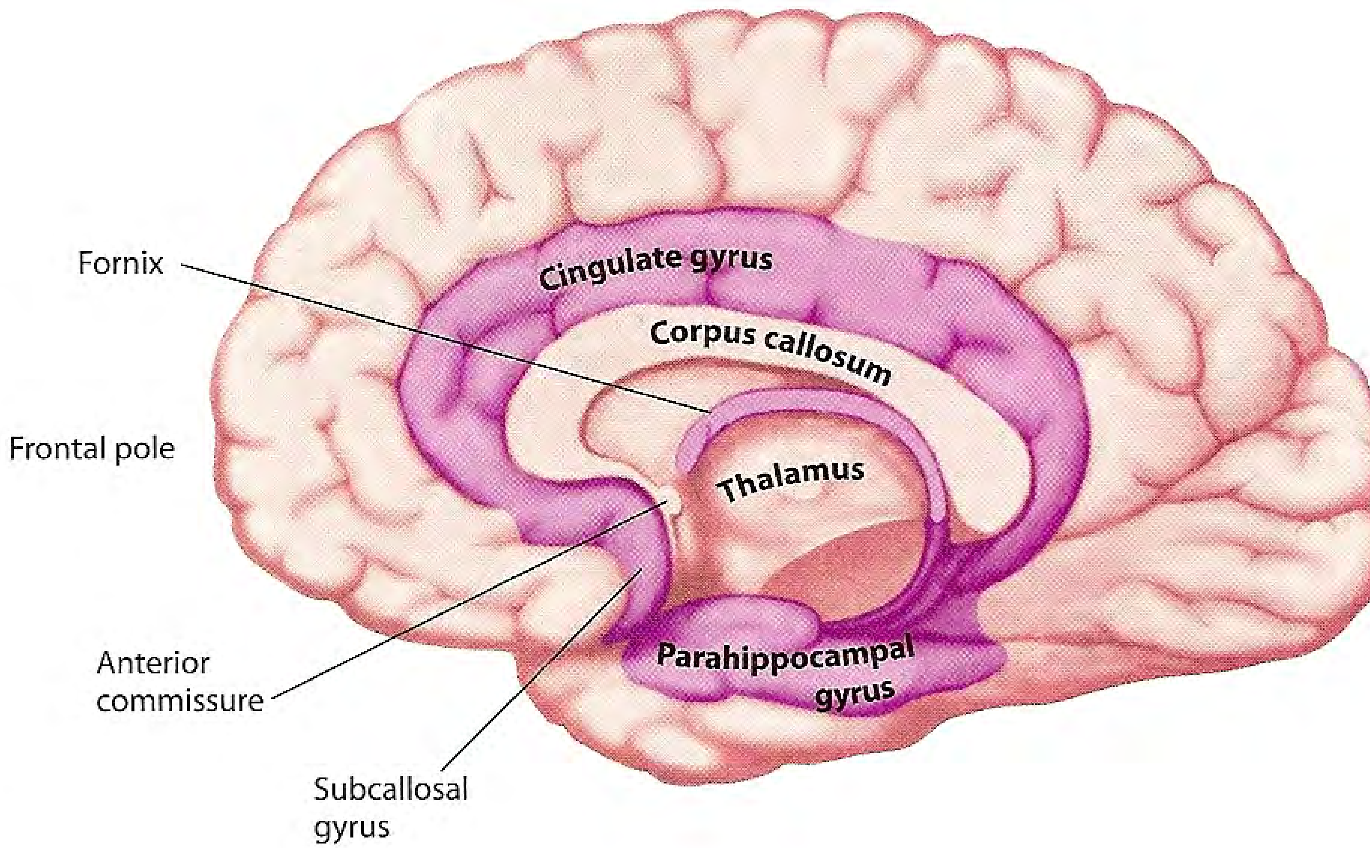


Figure 3.18 The limbic lobe as seen from a medial view of the right hemisphere. The structures that the limbic system comprises are in purple. These include the cingulate gyrus, the parahippocampal gyrus, and the subcallosal gyrus, as well as the dentate gyrus and hippocampal formation, which are not visible in this view.

The cerebral cortex:

Neocortex=the new cortex

sensoric, motoric, and association areas

*mesocortex

the paralimbic areas

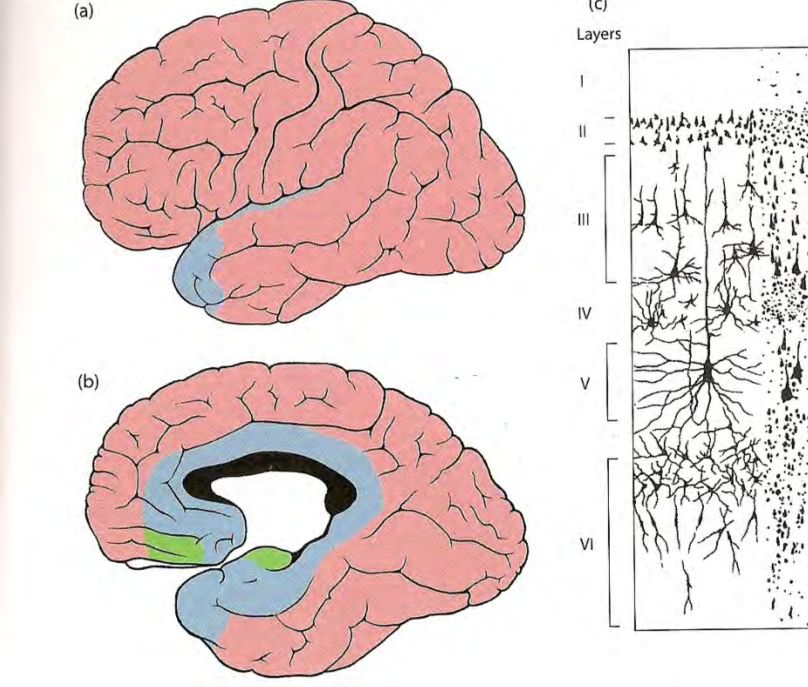
cortex cinguli, parahippocampal gyrus, cortex insula,

orbitofrontal cortex

*allocortex

hippocampus, olfactory cortex=the part of cortex receiving impulses from the olfactory bulbs

* Both mesocortex and allocortex is part of the limbic system



The cerebral cortex:

Neocortex=the new cortex

sensoric, motoric, and association areas

*mesocortex

the paralimbic areas

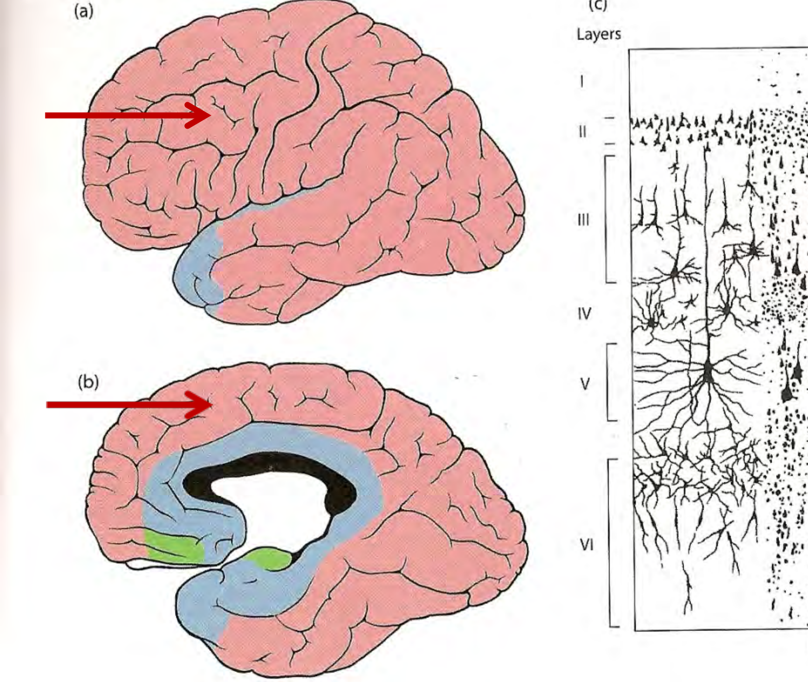
cortex cinguli, parahippocampal gyrus, cortex insula,

orbitofrontal cortex

*allocortex

hippocampus, olfactory cortex=the part of cortex receiving impulses from the olfactory bulbs

* Both mesocortex and allocortex is part of the limbic system



The cerebral cortex:

Neocortex=the new cortex

sensoric, motoric, and association areas

*mesocortex

the paralimbic areas

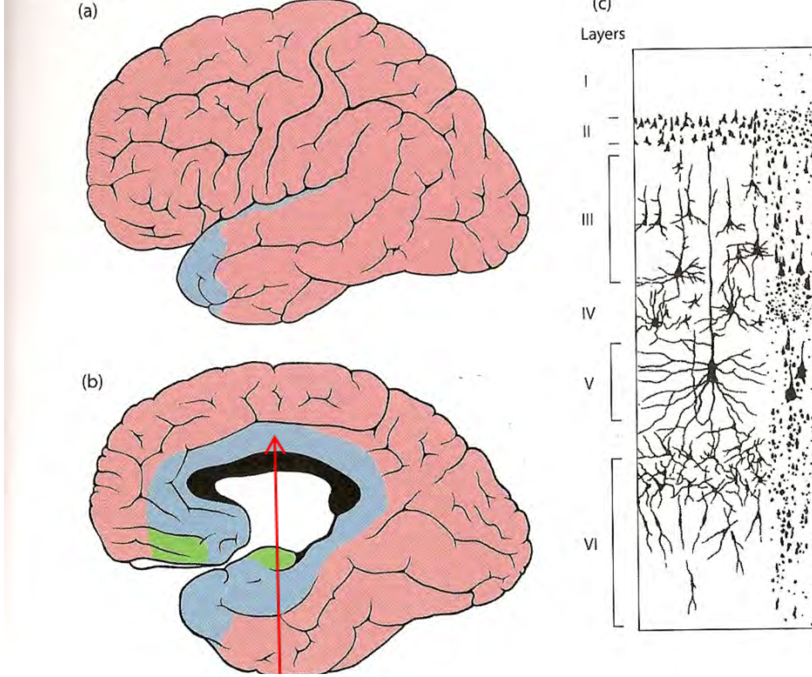
cortex cinguli, parahippocampal gyrus, cortex insula,

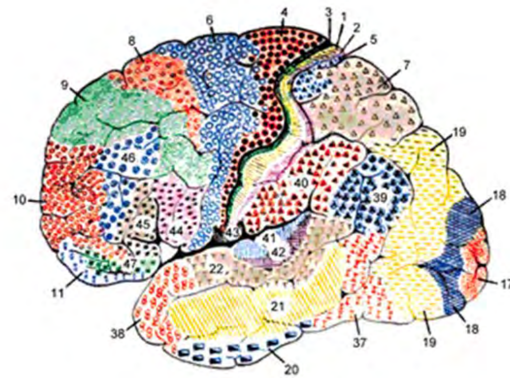
orbitofrontal cortex

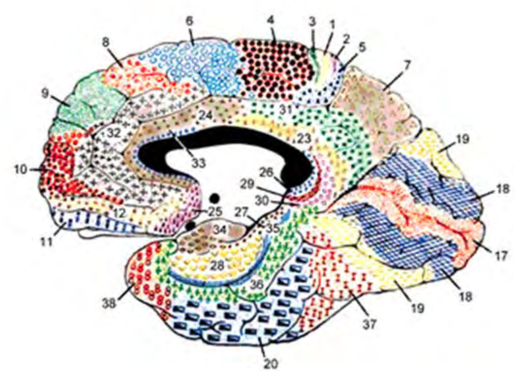
*allocortex

hippocampus, olfactory cortex=the part of cortex receiving impulses from the olfactory bulbs

* Both mesocortex and allocortex is part of the limbic system







The cerebral cortex:

Neocortex=the new cortex

sensoric, motoric, and association areas

*mesocortex

the paralimbic areas

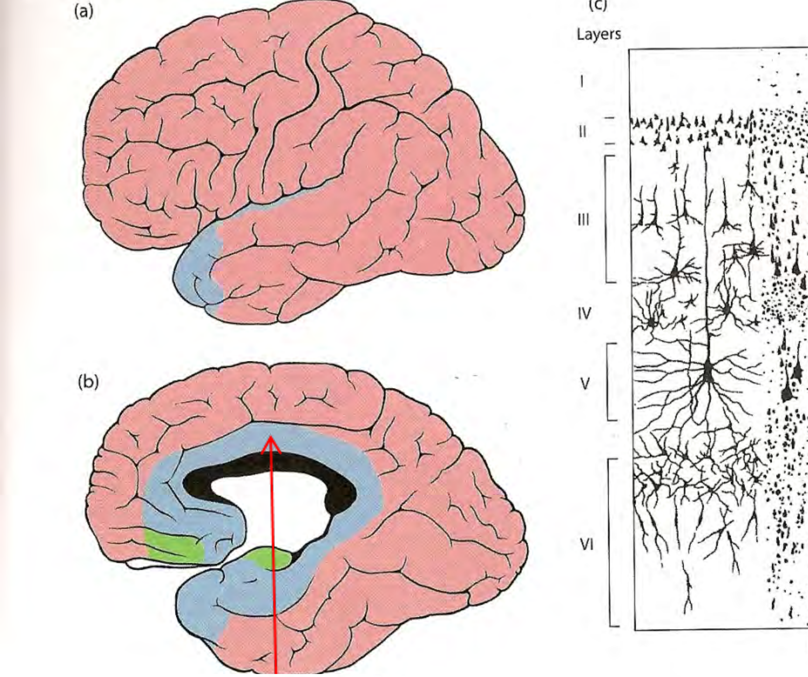
cortex cinguli, parahippocampal gyrus, cortex insula,

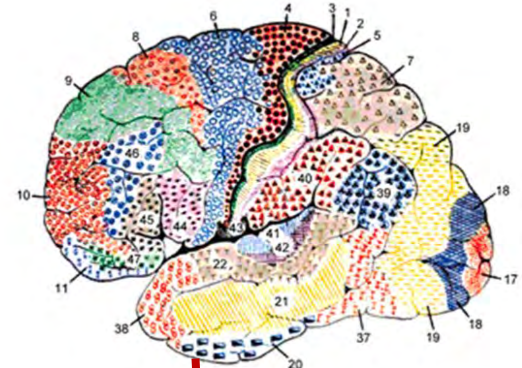
orbitofrontal cortex

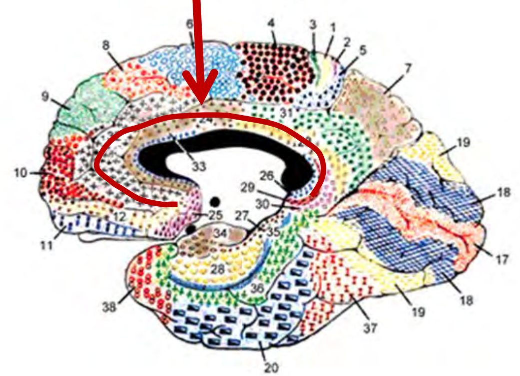
*allocortex

hippocampus, olfactory cortex=the part of cortex receiving impulses from the olfactory bulbs

* Both mesocortex and allocortex is part of the limbic system







The cerebral cortex:

Neocortex=the new cortex

sensoric, motoric, and association areas

*mesocortex

the paralimbic areas

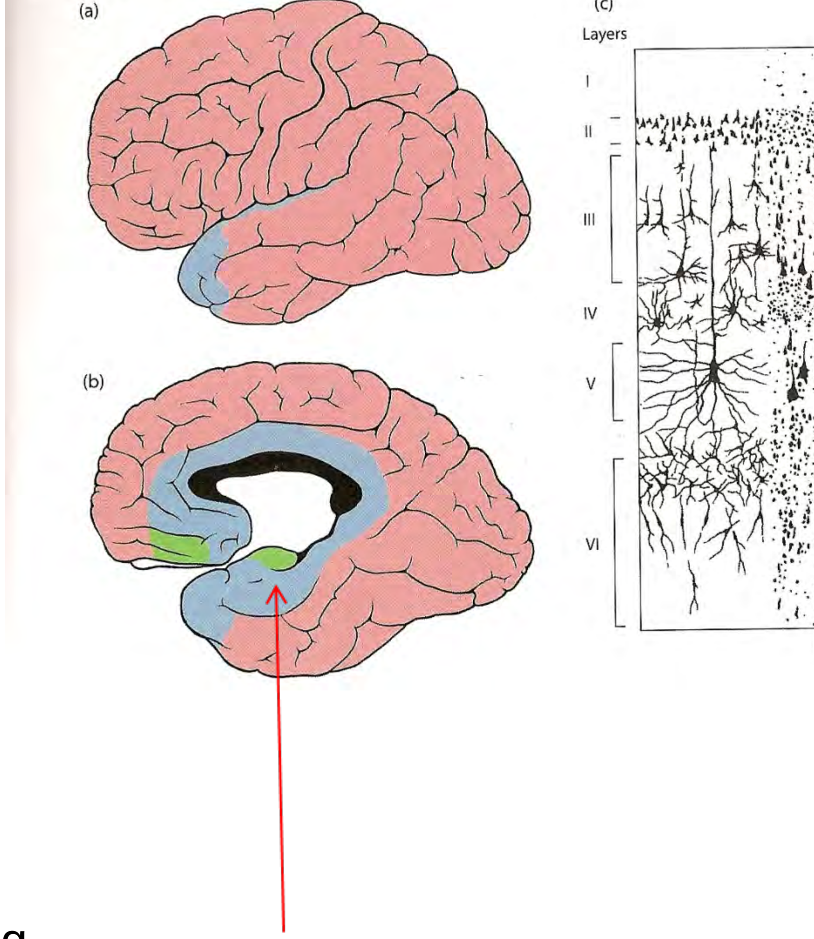
cortex cinguli, parahippocampal gyrus, cortex insula,

orbitofrontal cortex

*allocortex

hippocampus, olfactory cortex=the part of cortex receiving impulses from the olfactory bulbs

* Both mesocortex and allocortex is part of the limbic system



The cerebral cortex:

Neocortex=the new cortex

sensoric, motoric, and association areas

*mesocortex

the paralimbic areas

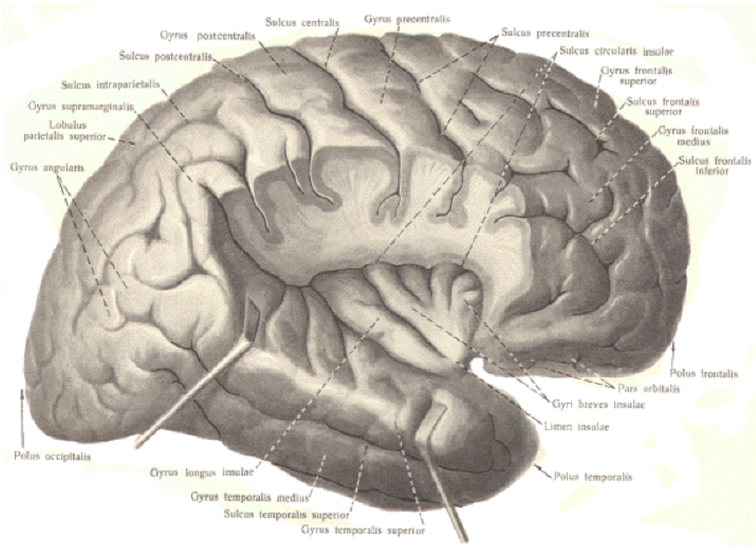
cortex cinguli, parahippocampal gyrus, cortex insula,

orbitofrontal cortex

*allocortex

hippocampus, olfactory cortex=the part of cortex receiving impulses from the olfactory bulbs

* Both mesocortex and allocortex is part of the limbic system



The cerebral cortex:

Neocortex=the new cortex

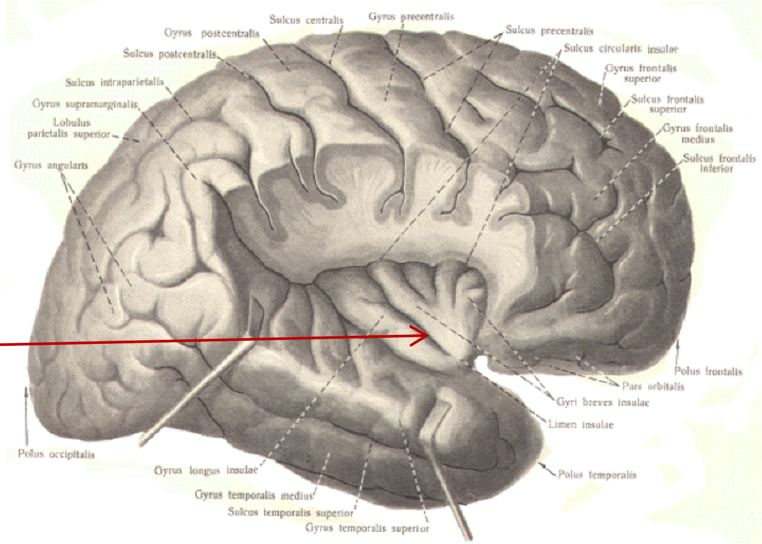
sensoric, motoric, and association areas

*mesocortex

the paralimbic areas

cortex cinguli, parahippocampal gyrus, cortex insula,

orbitofrontal cortex



*allocortex

hippocampus, olfactory cortex=the part of cortex receiving impulses from the olfactory bulbs

* Both mesocortex and allocortex is part of the limbic system

The cerebral cortex:

Neocortex=the new cortex

sensoric, motoric, and association areas

*mesocortex

the paralimbic areas

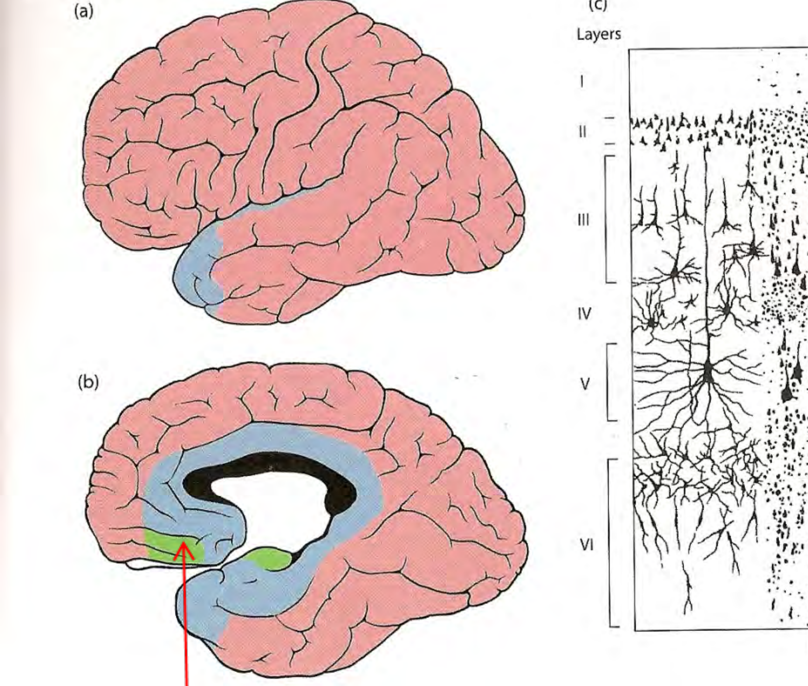
cortex cinguli, parahippocampal gyrus, cortex insula,

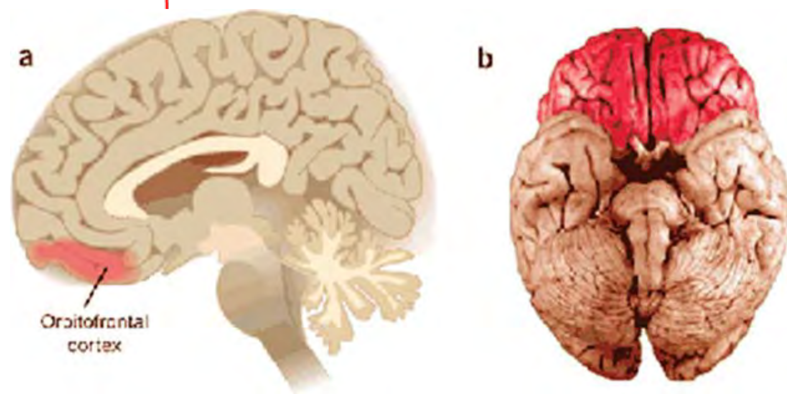
orbitofrontal cortex: higher order cx. for smell and gustation; rewarding mechanisms!!!

*allocortex

hippocampus, olfactory cortex=the part of cortex receiving impulses from the olfactory bulbs

* Both mesocortex and allocortex is part of the limbic system





The cerebral cortex:

Neocortex=the new cortex

sensoric, motoric, and association areas

*mesocortex

the paralimbic areas

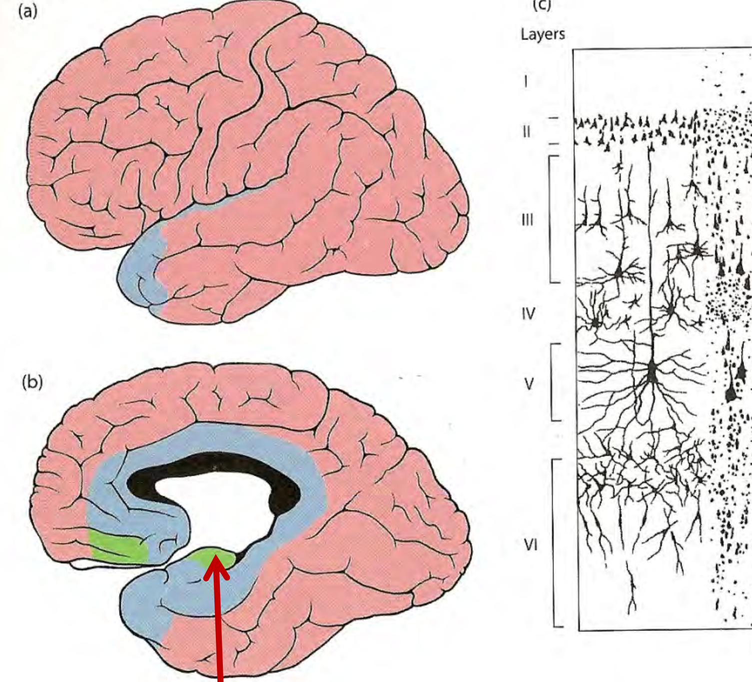
cortex cinguli, parahippocampal gyrus, cortex insula,

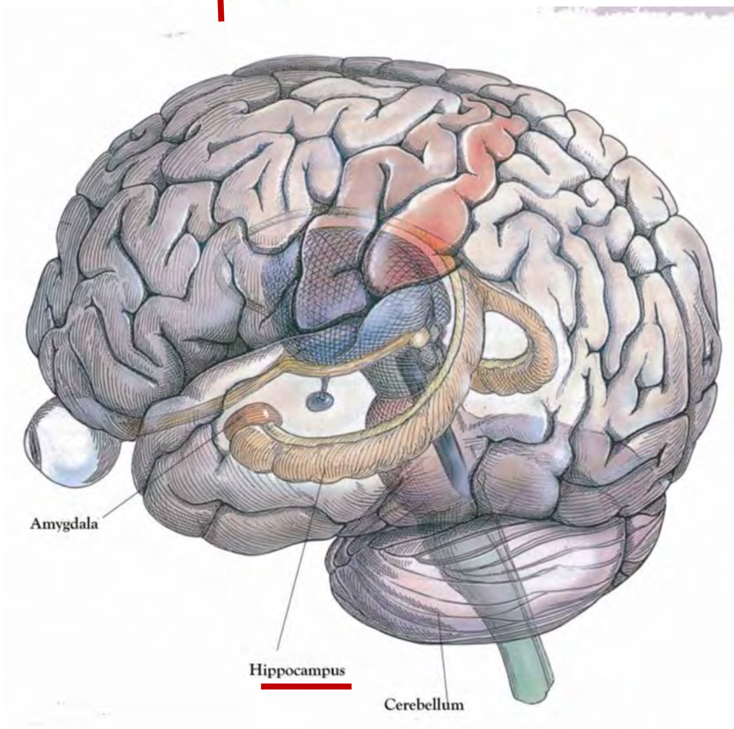
orbitofrontal cortex

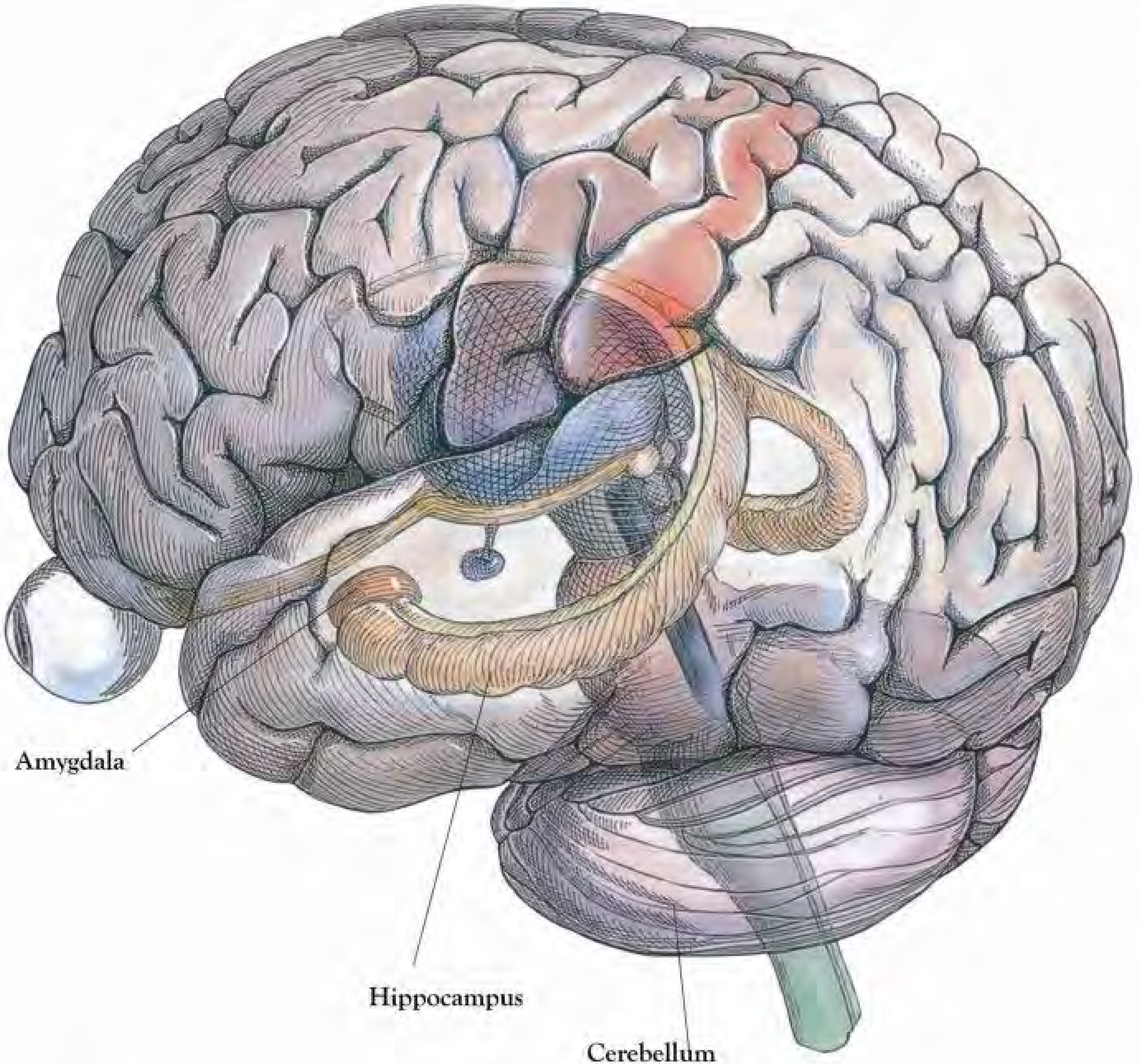
*allocortex

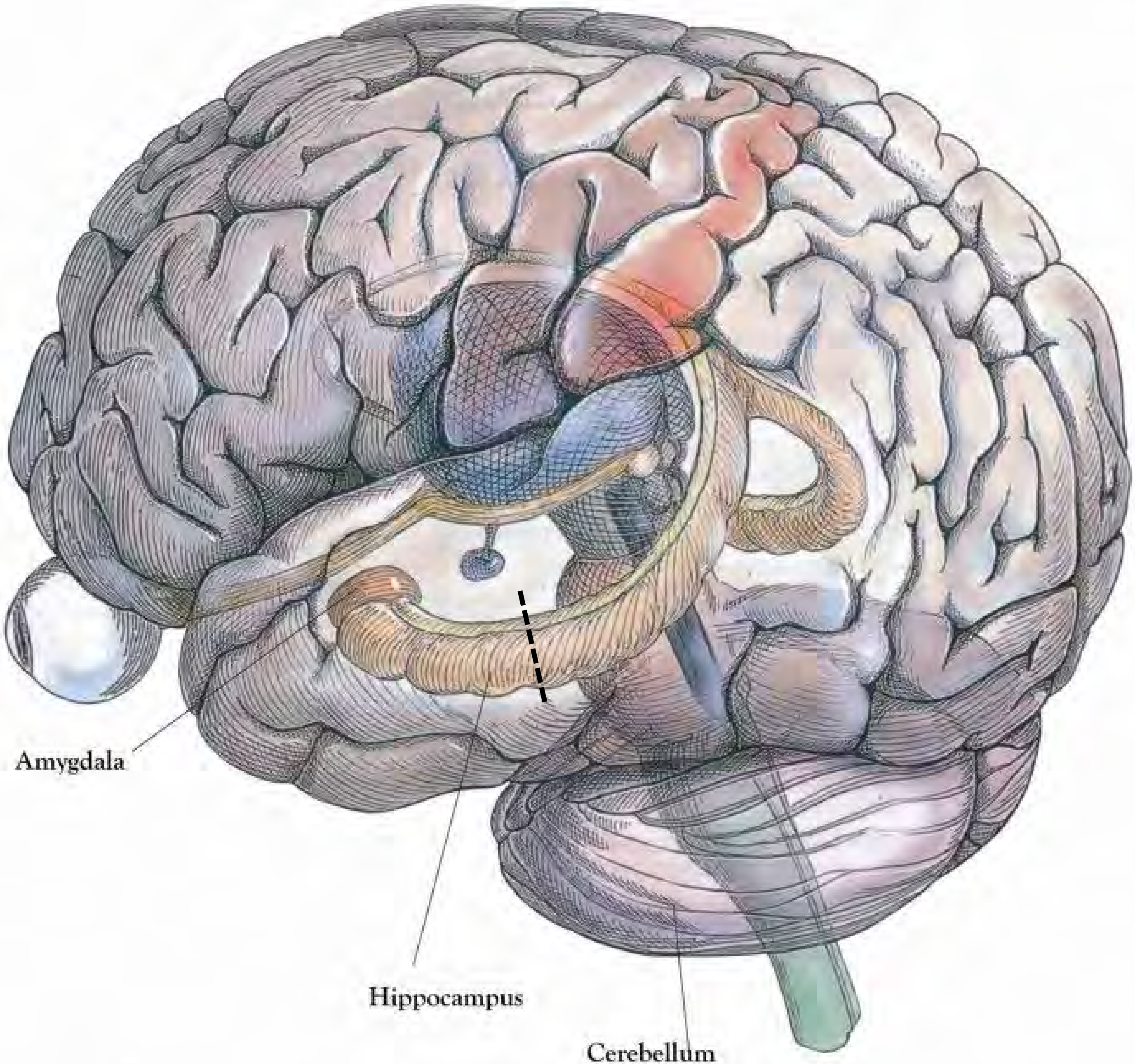
hippocampus, olfactory cortex=the part of cortex receiving impulses from the olfactory bulbs

* Both mesocortex and allocortex is part of the limbic system

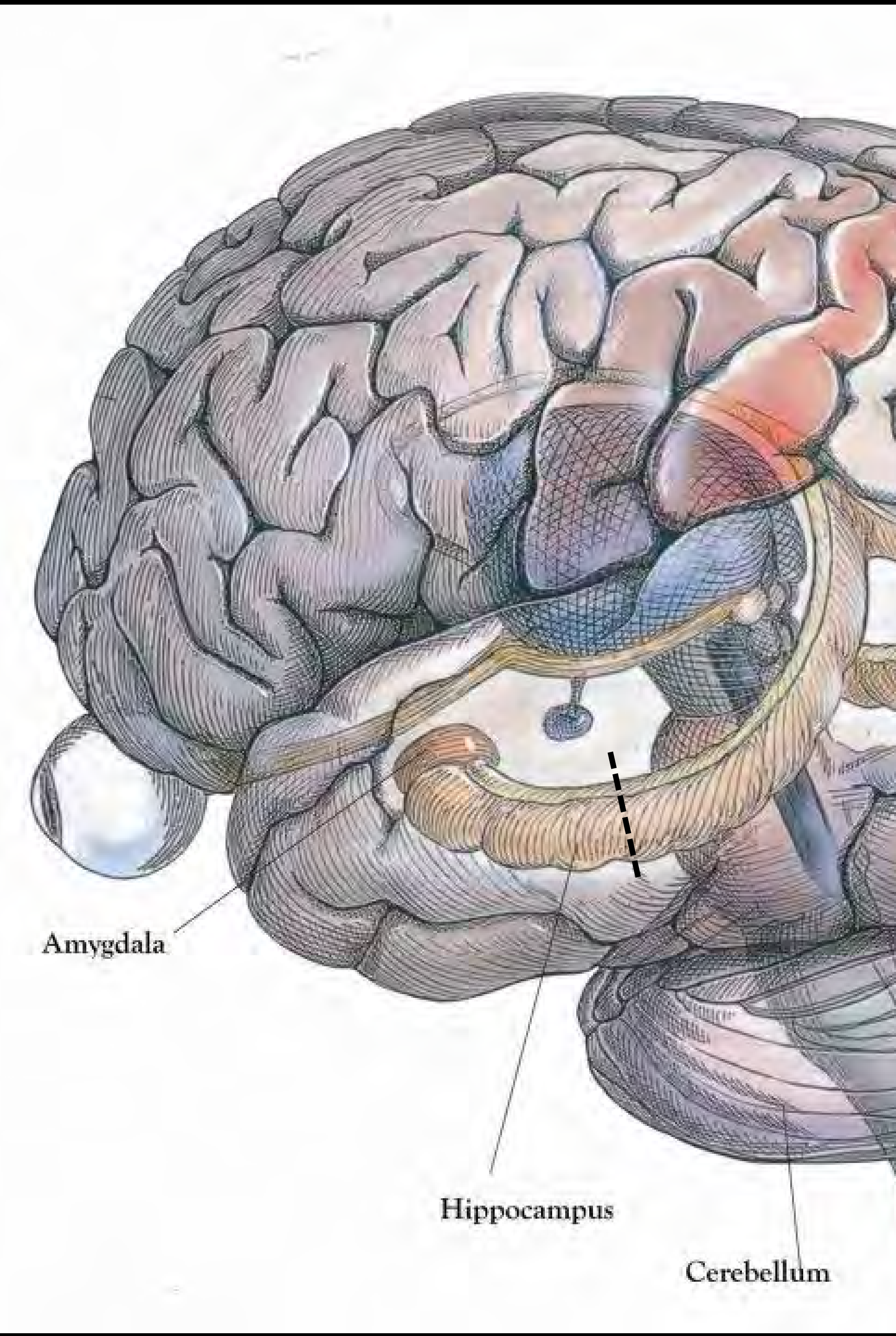


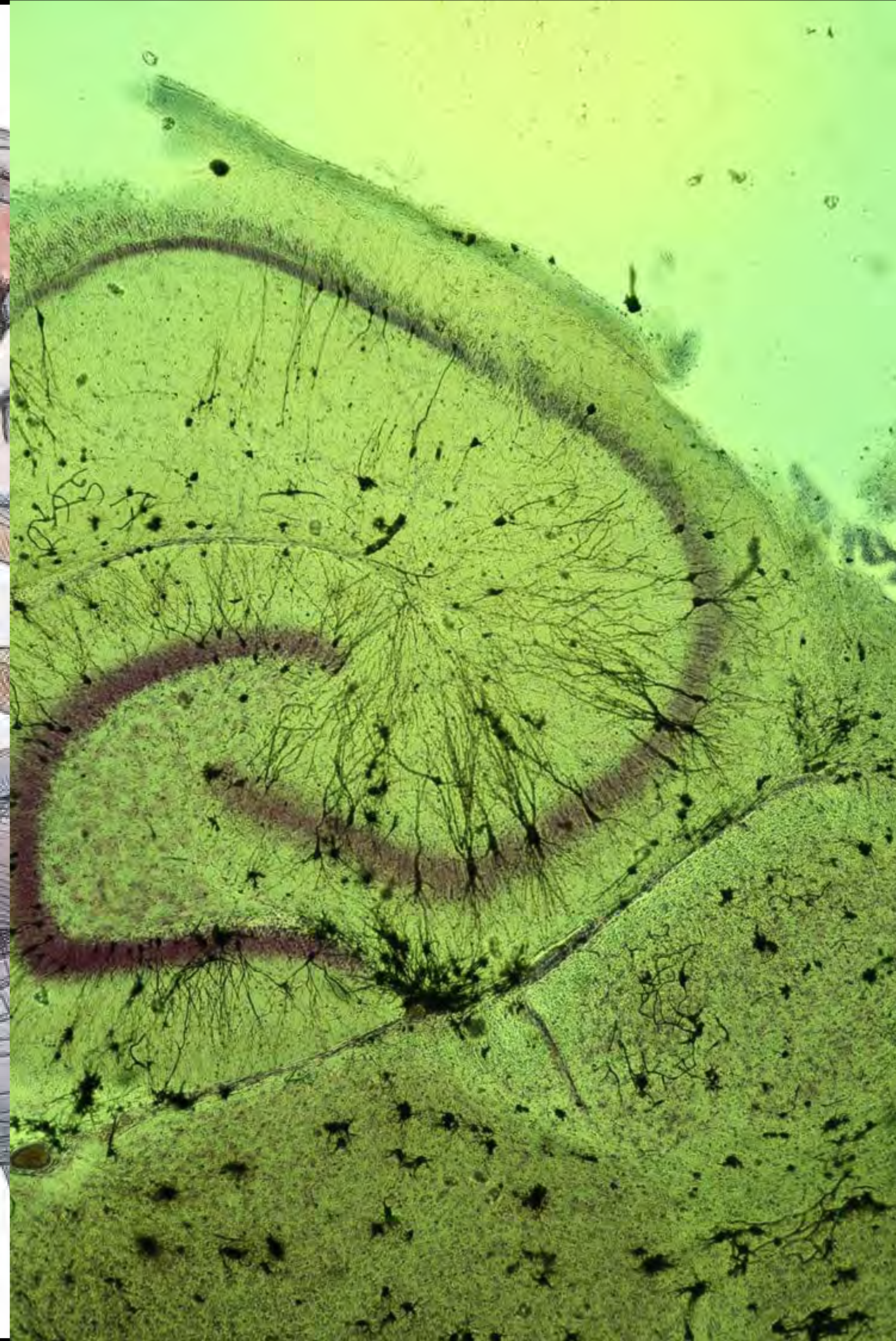



Amygdala
Hippocampus
Cerebellum



Amygdala
Hippocampus
Cerebellum


Amygdala
Hippocampus
Cerebellum



The cerebral cortex:

Neocortex=the new cortex

sensoric, motoric, and association areas

*mesocortex

the paralimbic areas

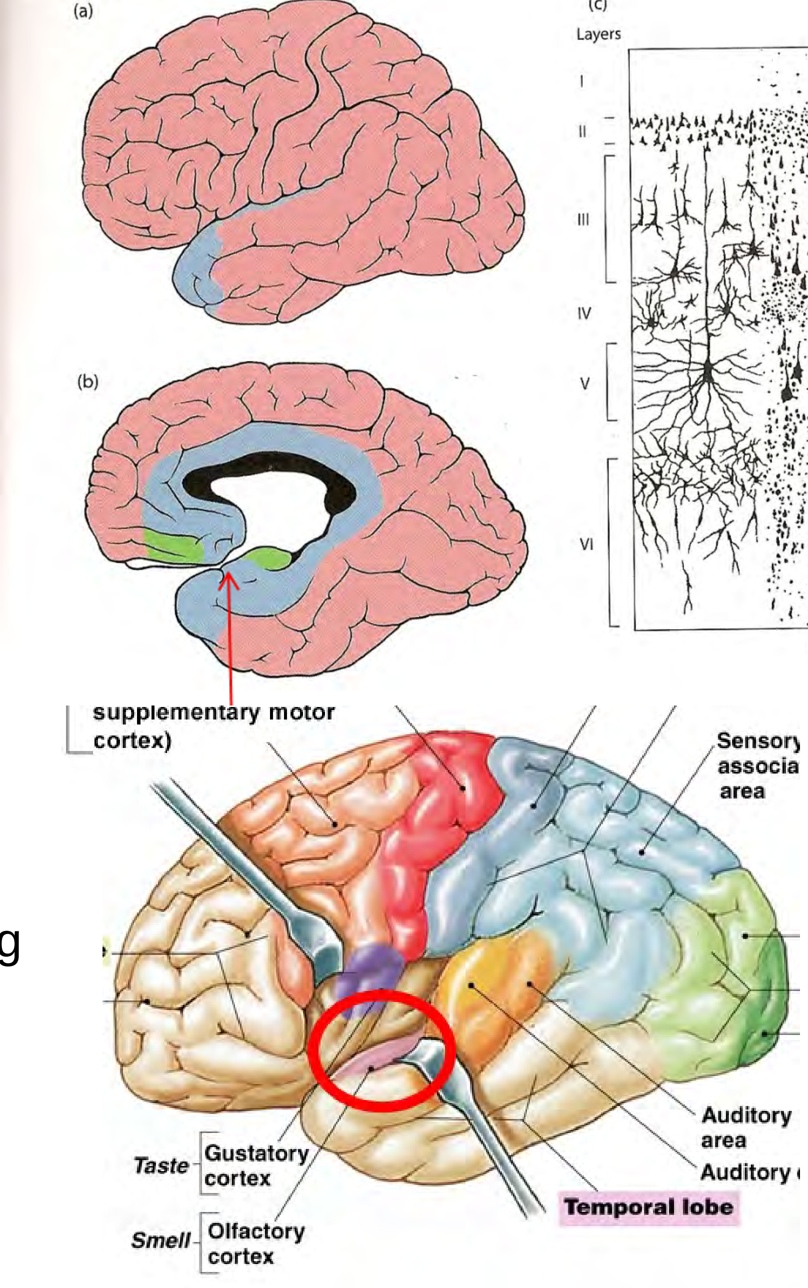
cortex cinguli, parahippocampal gyrus, cortex insula,

orbitofrontal cortex

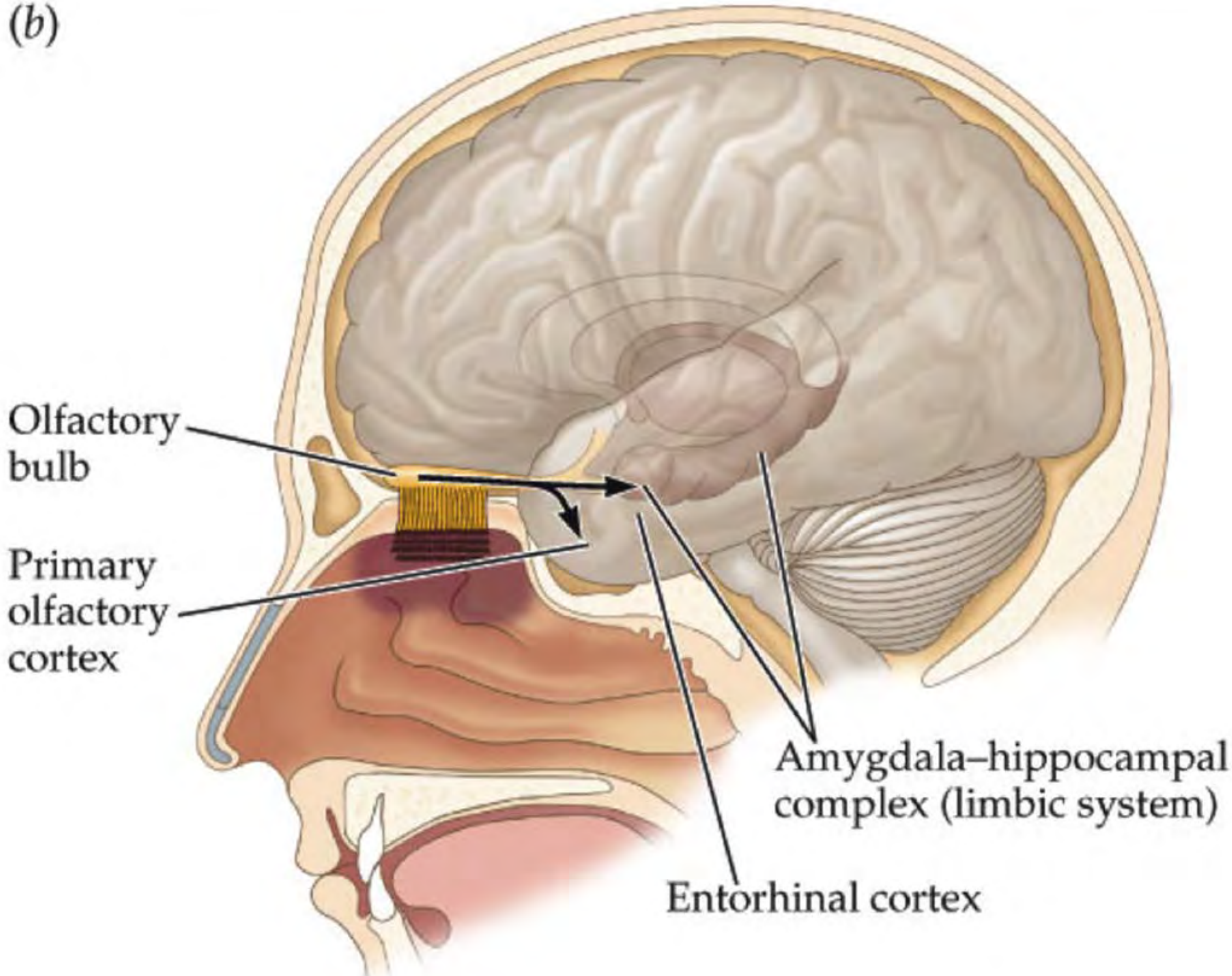
*allocortex

hippocampus, olfactory cortex=the part of cortex receiving impulses from the olfactory bulbs

* Both mesocortex and allocortex is part of the limbic system

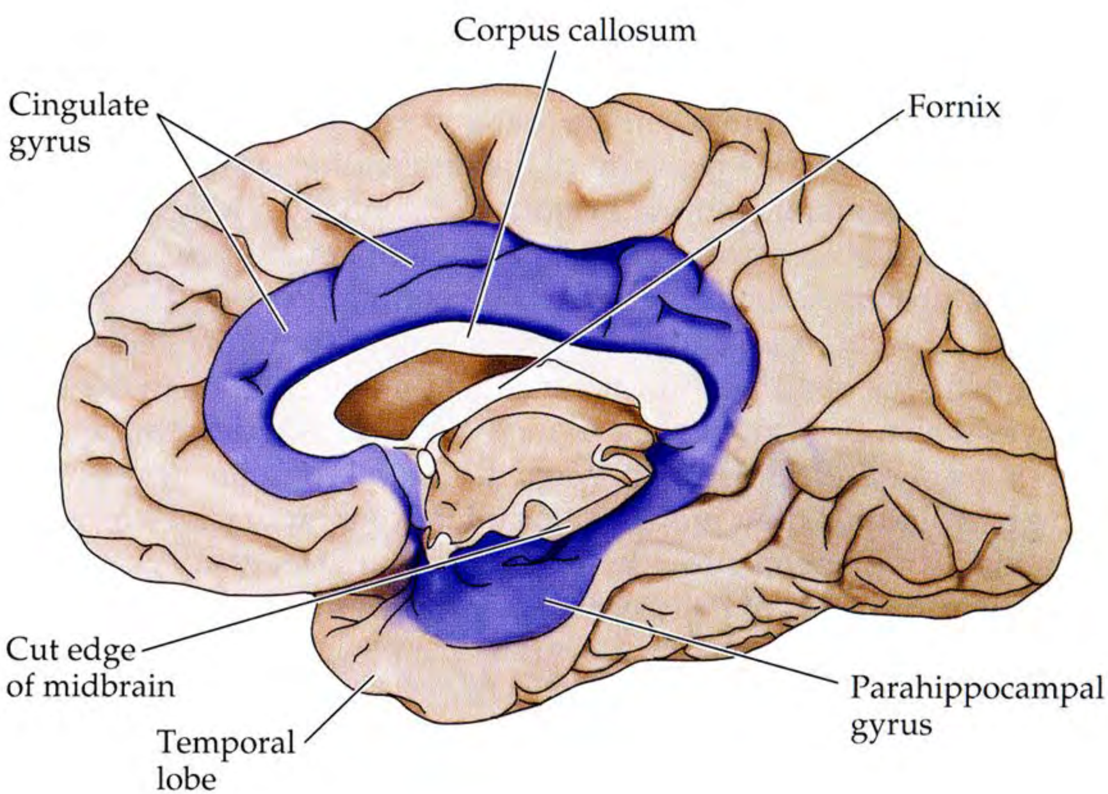


(b)


Olfactory bulb
Primary olfactory cortex
Amygdala–hippocampal complex (limbic system)
Entorhinal cortex

Paul Broca described this emotional part of the brain *il grand lobe limbique*: the great limbic ring:

cortex cinguli, hypothalamus, the anterior nuclei of thalamus, and the hippocampus form what is called the "classic limbic ring".



Paul Broca (1824-1880)

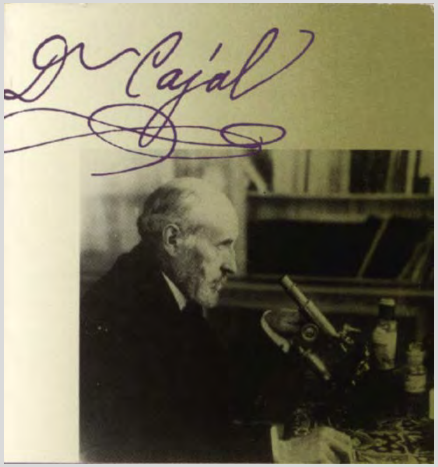
Paul Broca described this emotional part of the brain *il grand lobe limbique*: the great limbic ring:

cortex cinguli, hypothalamus, the anterior nuclei of thalamus, and the hippocampus form what is called the "classic limbic ring".

In the 1930s it was James Papez who first put forward the hypothesis that these structures were organized as a system of emotions. The limbic system was therefore also called "Papez circuit".

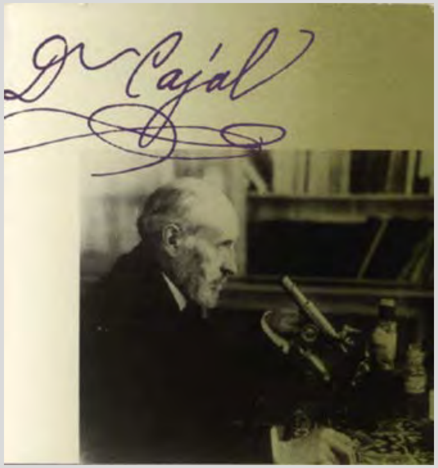
The anatomy of the nerve cell and its history of research


Prof.r Camillo Golgi



Golgi's method is a nervous tissue staining technique discovered by Italian physician and scientist Camillo Golgi (1843–1926) in 1873. It was initially named the black reaction (la reazione nera) by Golgi, but it became better known as the Golgi stain or later, Golgi method.

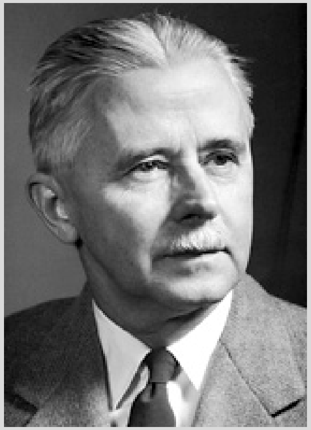
Golgi' staining was famously used by Spanish neuroanatomist Santiago Ramón y Cajal (1852–1934) to discover a number of novel facts about the organization of the nervous system, inspiring the birth of the neuron doctrine. Ultimately, Ramon y Cajal improved the technique by using a method he termed "double impregnation." Ramon y Cajal's staining technique, still in use, is called Cajal's Stain.



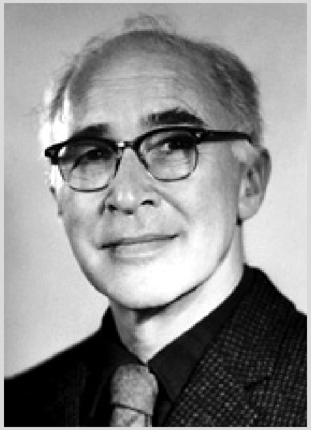
Is the nervous system a complex network or , where the large neurons communicate with small ones, organized in transverse plexus , a view that was advocated by Golgi and Tartuferi, or is it a communication from cell to cell in a linear, which was the thesis set forth by S.R. y Cajals syn?

H.K. Hartline, R. Granit and G. Wald received the nobel prize in medisin and phfysiology in the year 1967 on a basis of studies which gave support to the view of Golgi and Tartuferi; they prooved that the nervous system was more of a reticulum that a ”point-to-point” communication.

R. Granit



H.K. Hartline



G. Wald

Golgi's method stains a limited number of cells at random in their entirety. The mechanism by which this happens is still largely unknown.

Dendrites, as well as the cell soma, are clearly stained in brown and black and can be followed in their entire length, which allowed neuro-anatomists to track connections between neurons and to make visible the complex networking structure of many parts of the brain and spinal cord.

Golgi's staining is achieved by impregnating fixed nervous tissue with potassium dichromate and silver nitrate. Cells thus stained are filled by microcrystallization of silver chromate.

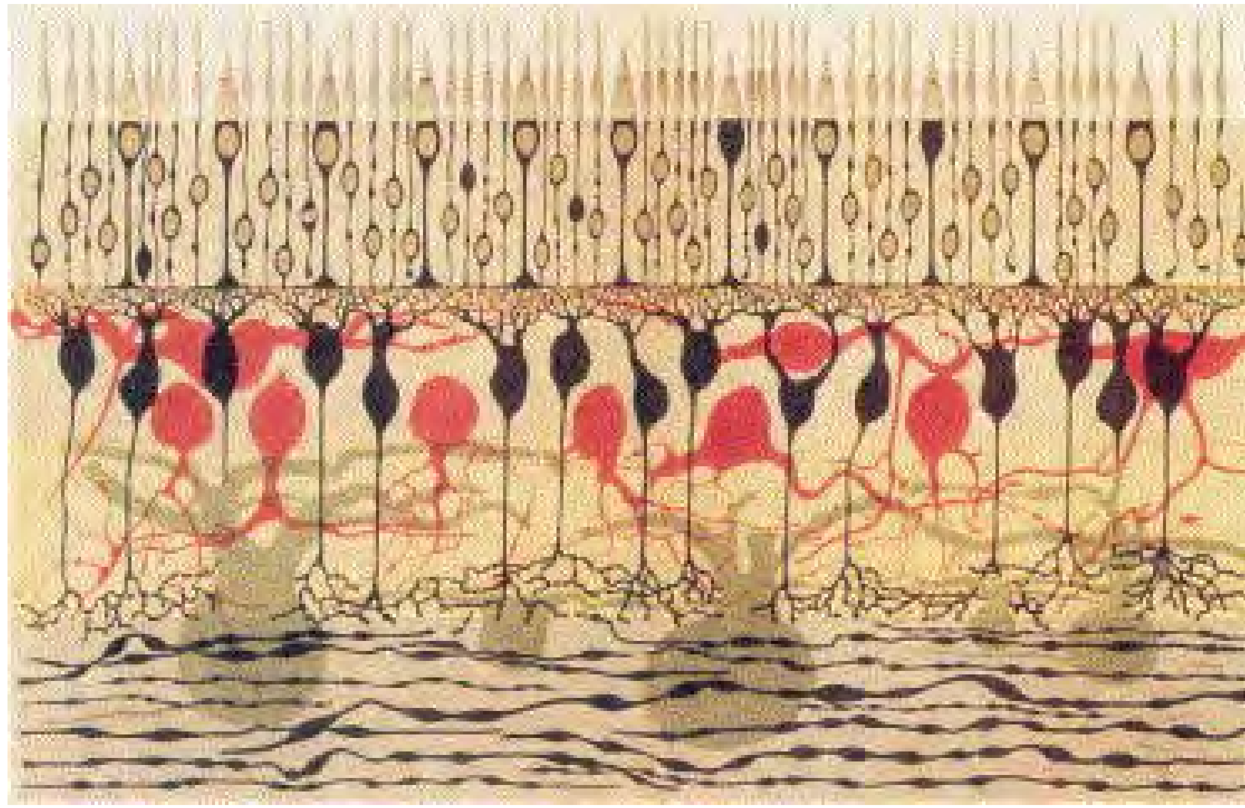
Silver chromate (Ag_2CrO_4) is a brown-red monoclinic crystal and is a chemical precursor to modern photography.

It can be formed by combining silver nitrate ($AgNO_3$) and potassium chromate (K_2CrO_4).

This reaction has been important in neuroscience, as it is used in the "Golgi method" of staining neurons for microscopy: the silver chromate produced precipitates inside neurons and makes their morphology visible.

Slik ser den ubalanserte reaksjonslikningen ut:

$$AgNO_3 + K_2CrO_4 = Ag_2CrO_4 + KNO_3$$

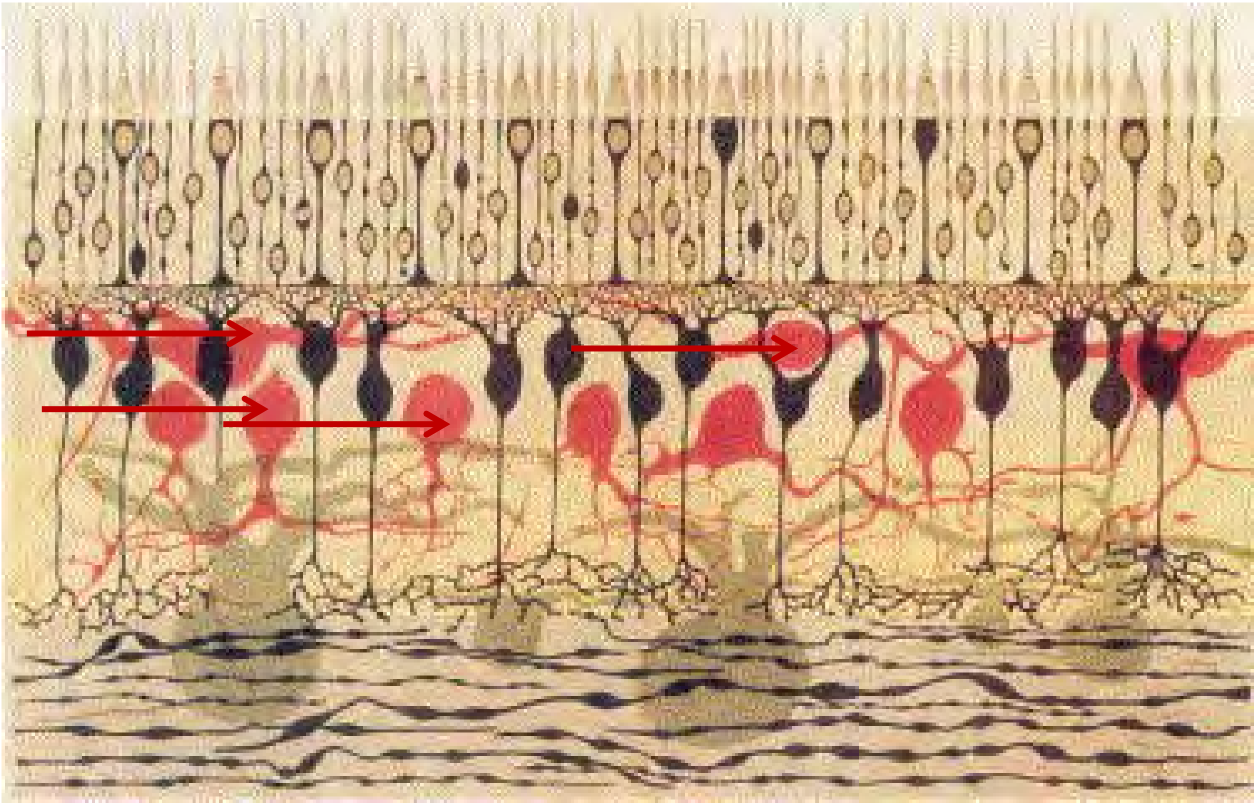
Ferruccio Tartuferi (1852-1925), with his beautiful drawing of the retina, stained with Golgi's method

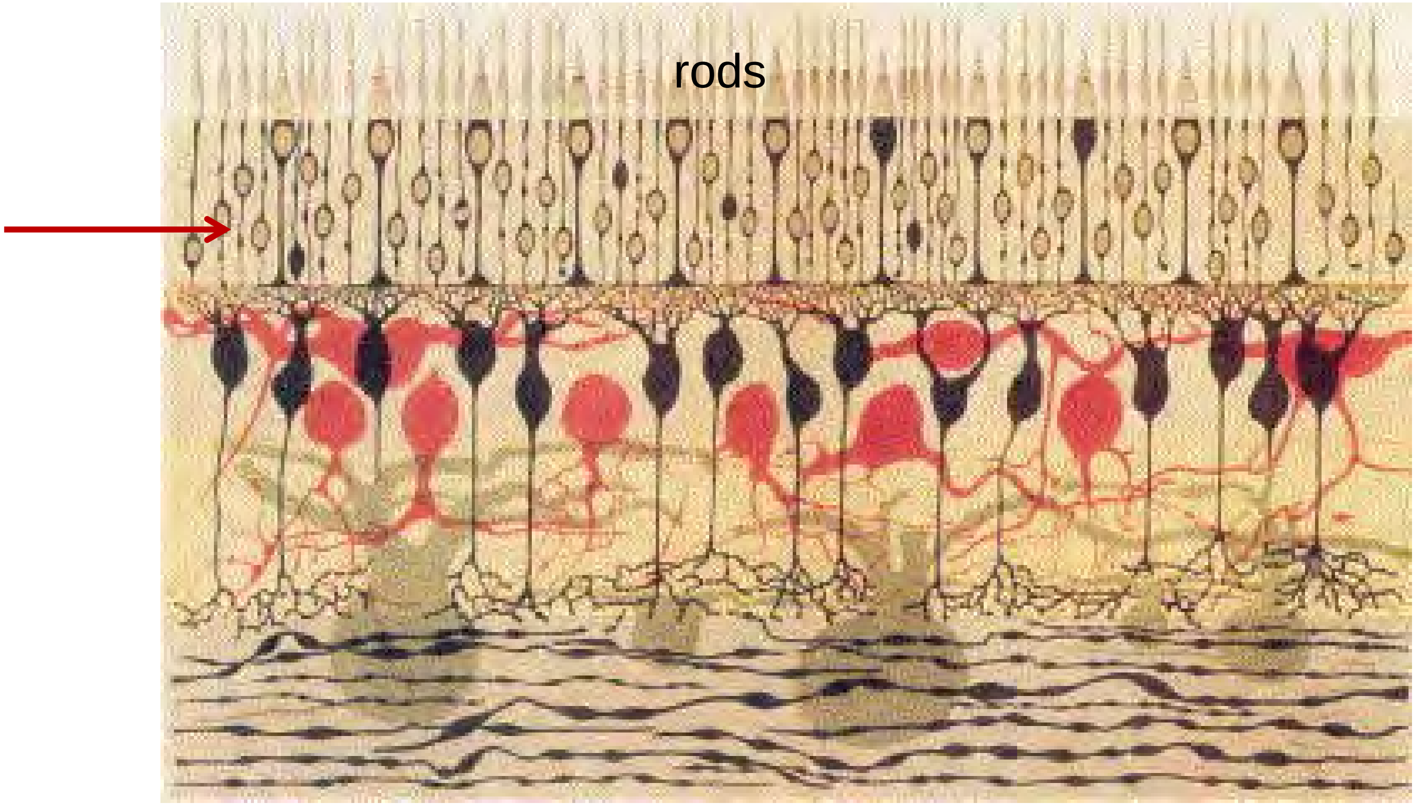
Tartuferi was a student of Golgi who had developed the *reazione nera* (black reaction) in 1873. He published a beautiful coloured illustration of the retina in 1887.

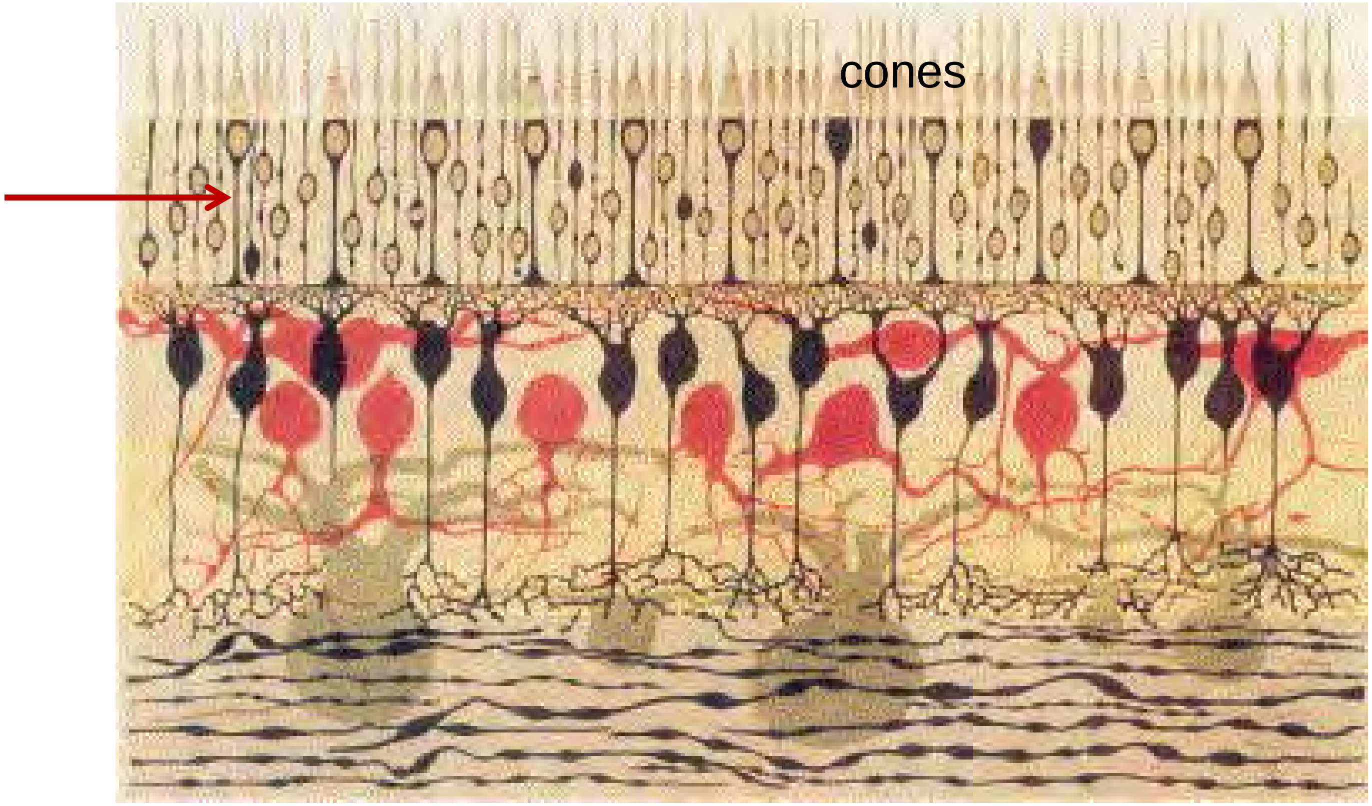
Despite the detailed representation of the constituent individual cells of the retina, Tartuferi retained Golgi's view that the nervous system was a reticulum of nerve cells.

horisontal cells

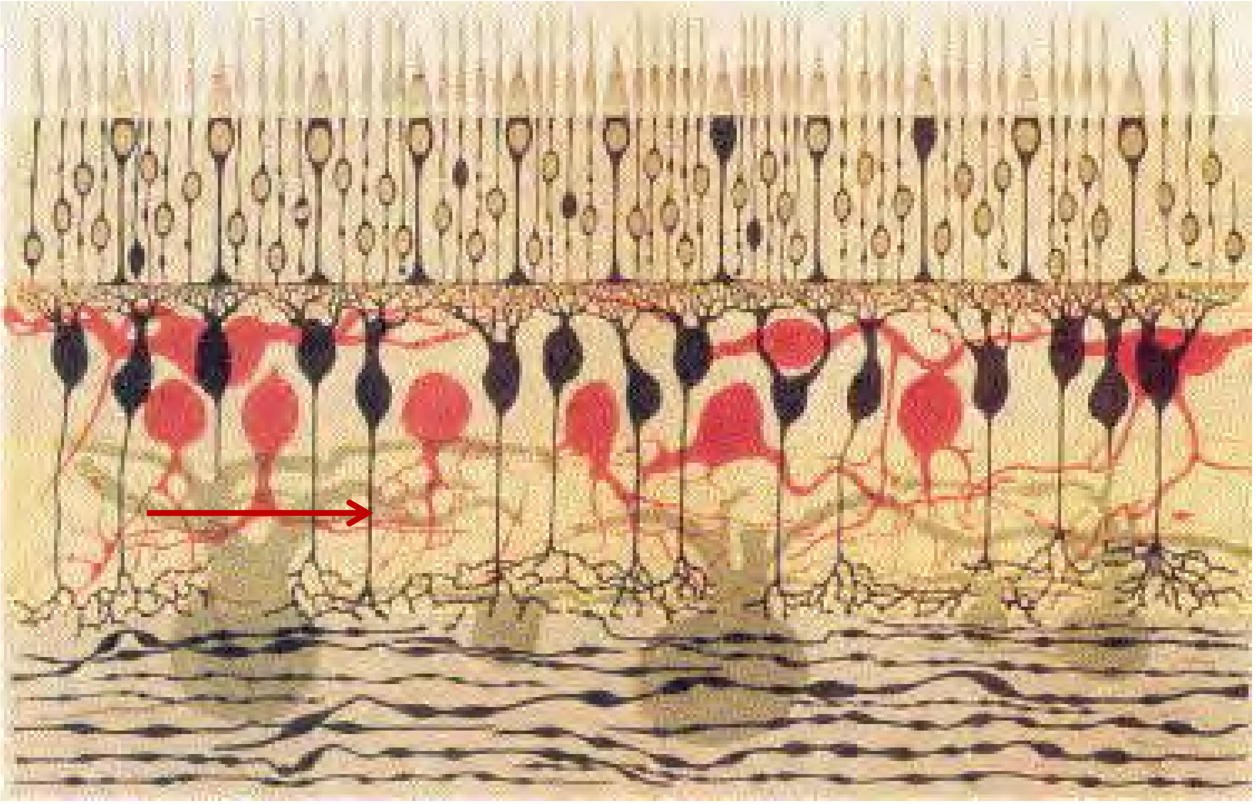
amacrine cells



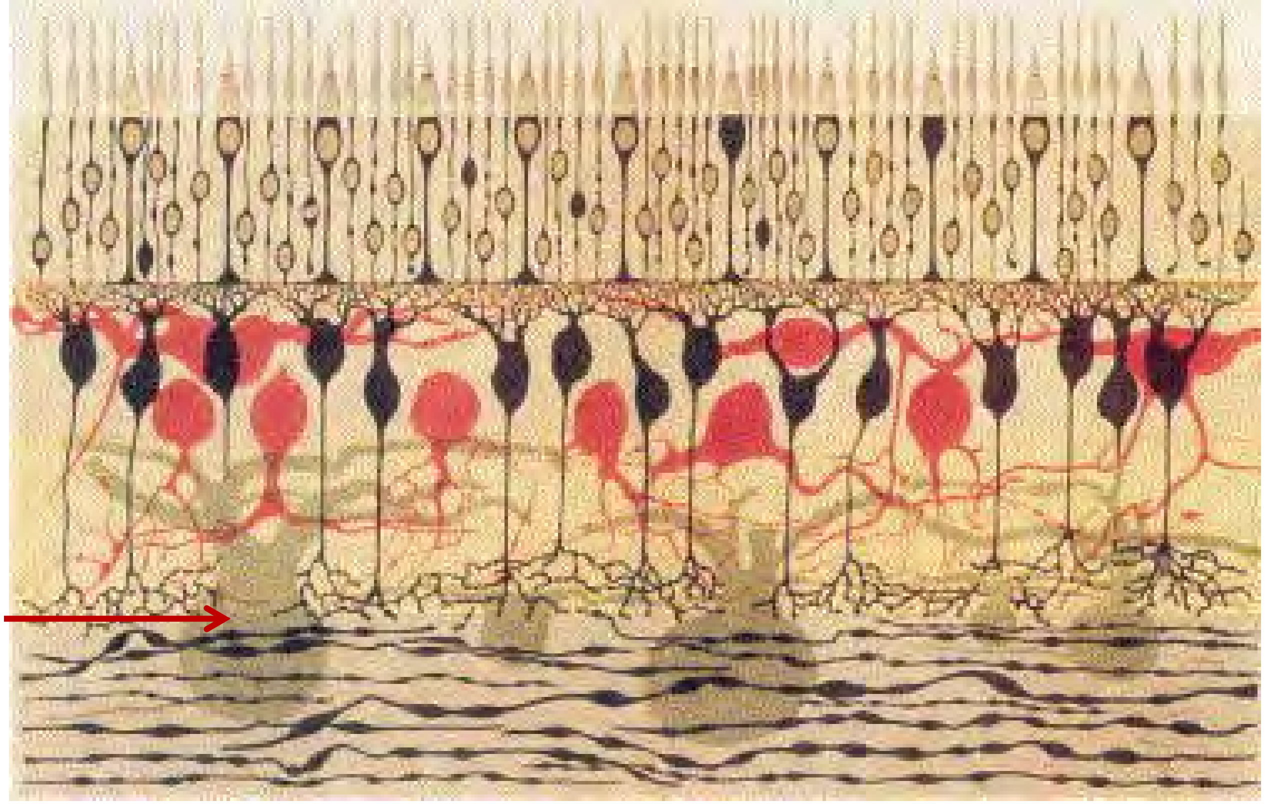

rods

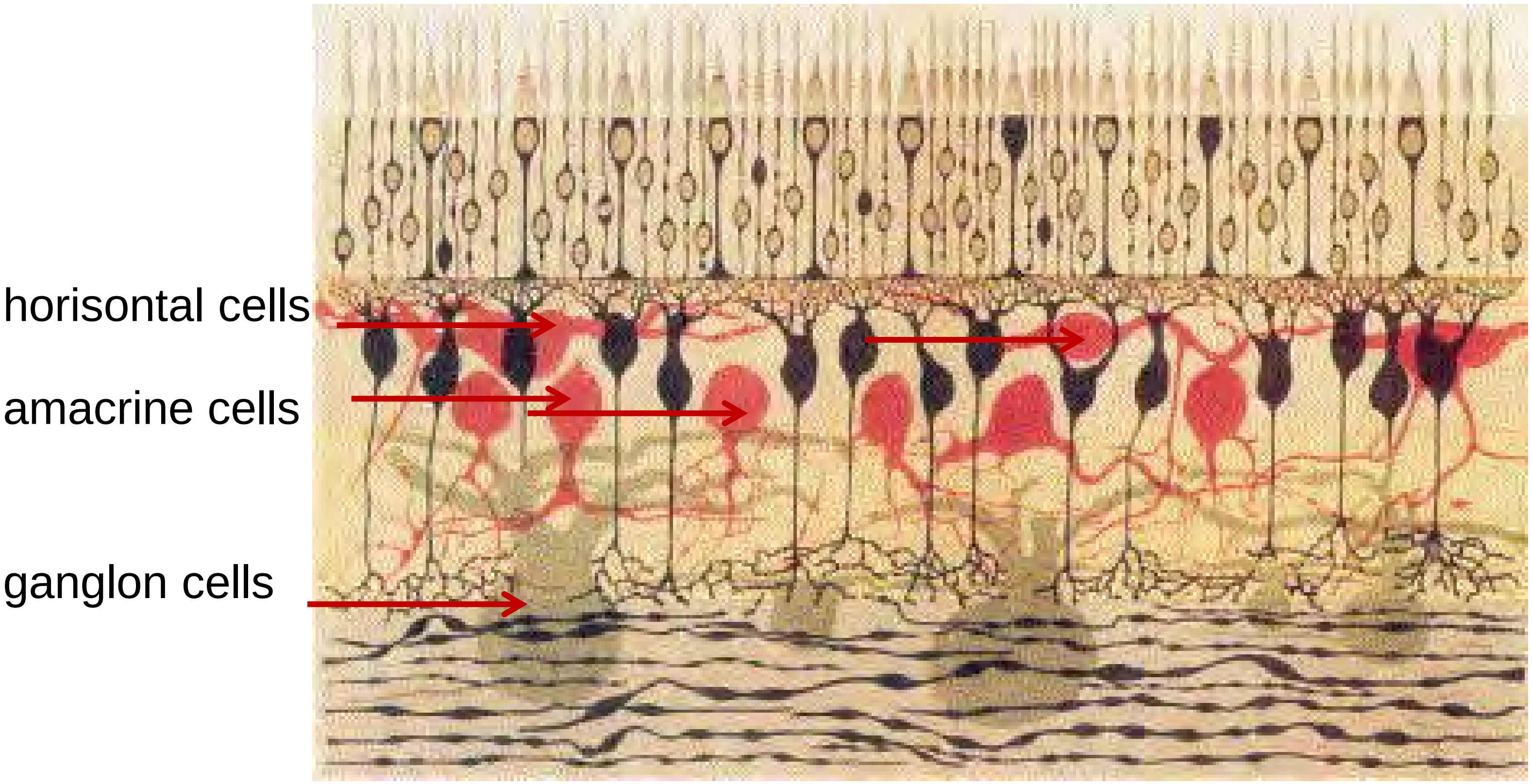

cones

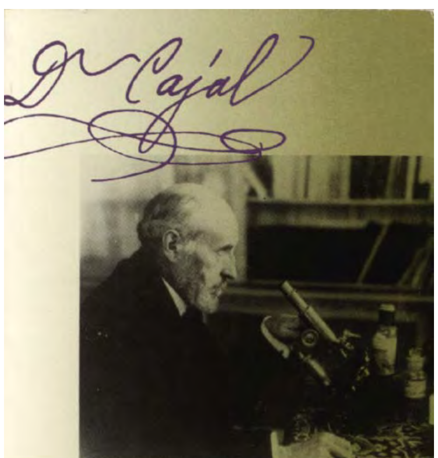
bipolar cells



ganglon cells




horisontal cells
amacrine cells
ganglon cells

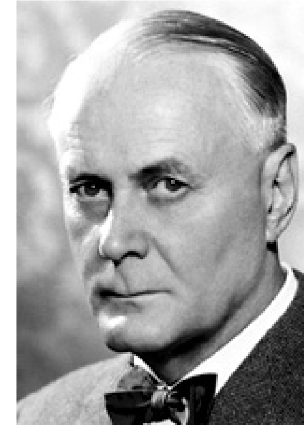


Golgi's method is a nervous tissue staining technique discovered by Italian physician and scientist Camillo Golgi (1843–1926) in 1873. It was initially named the black reaction (la reazione nera) by Golgi, but it became better known as the Golgi stain or later, Golgi method.

Golgi' staining was famously used by Spanish neuroanatomist Santiago Ramón y Cajal (1852–1934) to discover a number of novel facts about the organization of the nervous system, inspiring the birth of the neuron doctrine. Ultimately, Ramon y Cajal improved the technique by using a method he termed "double impregnation." Ramon y Cajal's staining technique, still in use, is called Cajal's Stain.

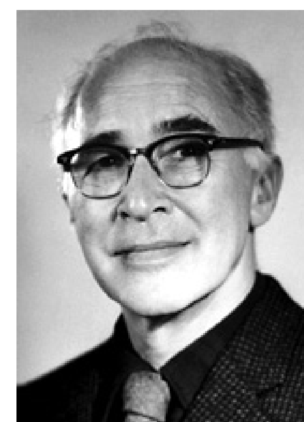
Is the nervous system a complex network or , where the large neurons communicate with small ones, organized in transverse plexus , a view that was advocated by Golgi and Tartuferi, or is it a communication from cell to cell in a linear, which was the thesis set forth by S.R. y Cajals syn?

H.K. Hartline, R. Granit and G. Wald received the nobel prize in medisin and phfysiology in the year 1967 on a basis of studies which gave support to the view of Golgi and Tartuferi; they prooved that the nervous system was more of a reticulum that a ”point-to-point” communication.

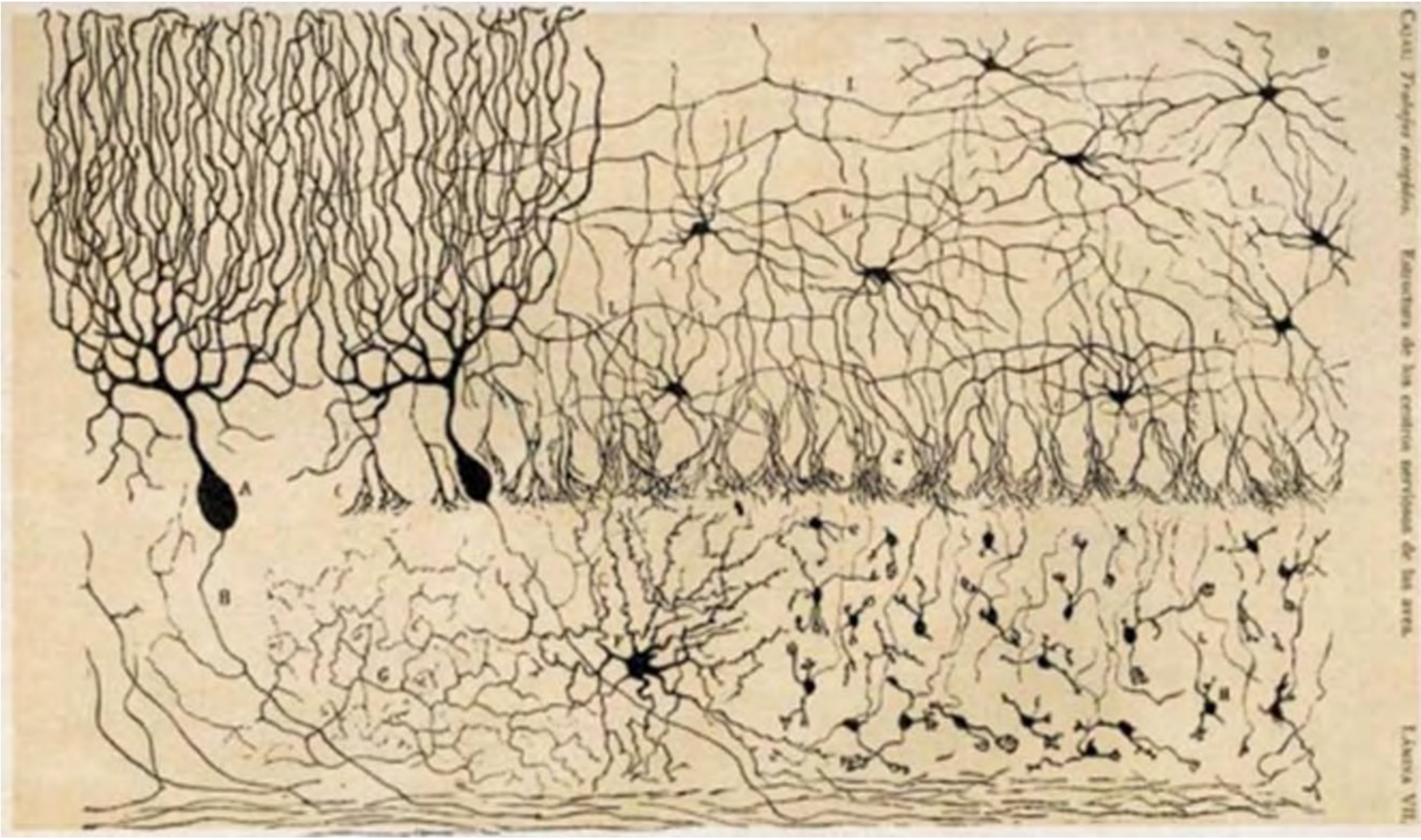


R. Granit

H.K. Hartline

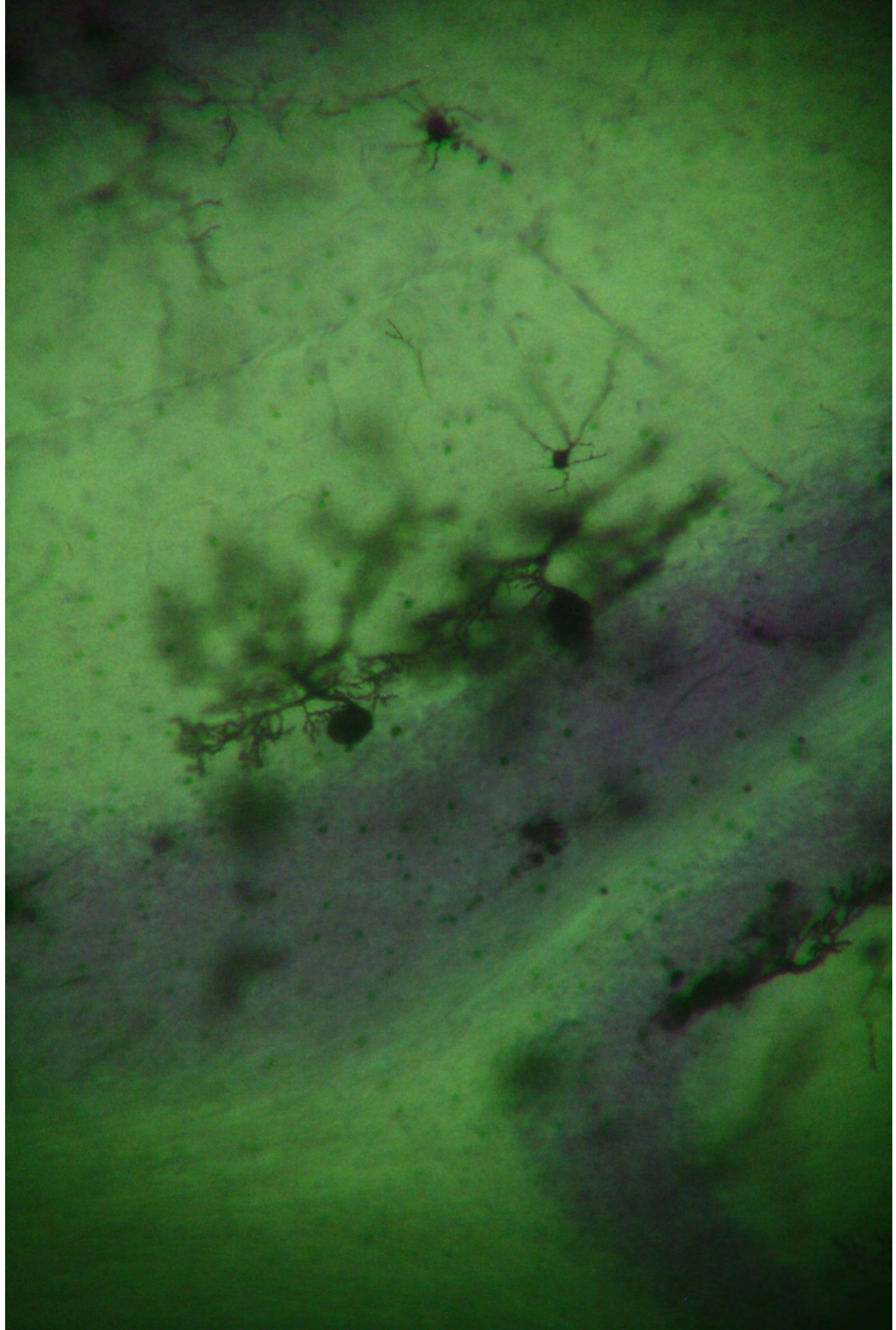


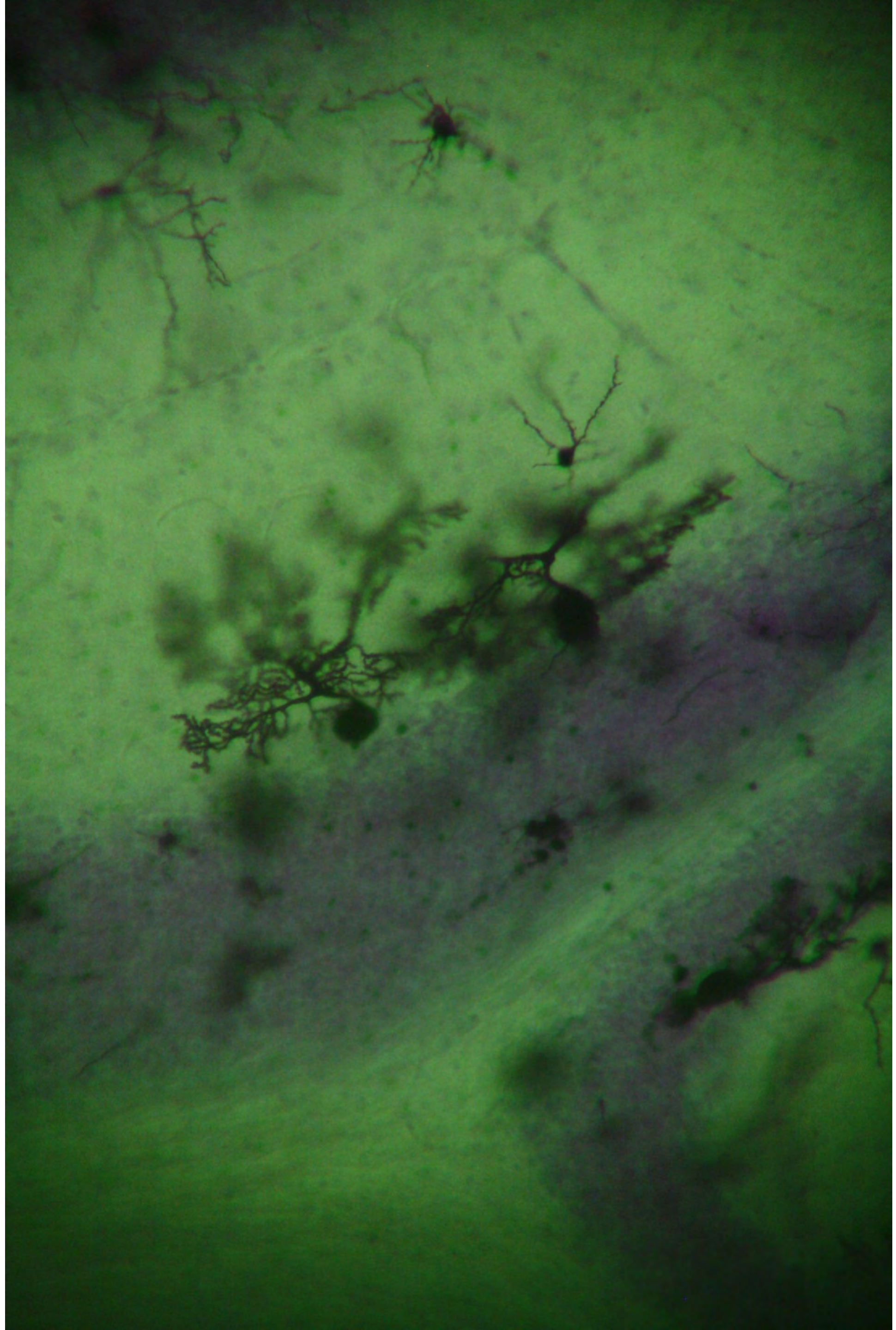
G. Wald

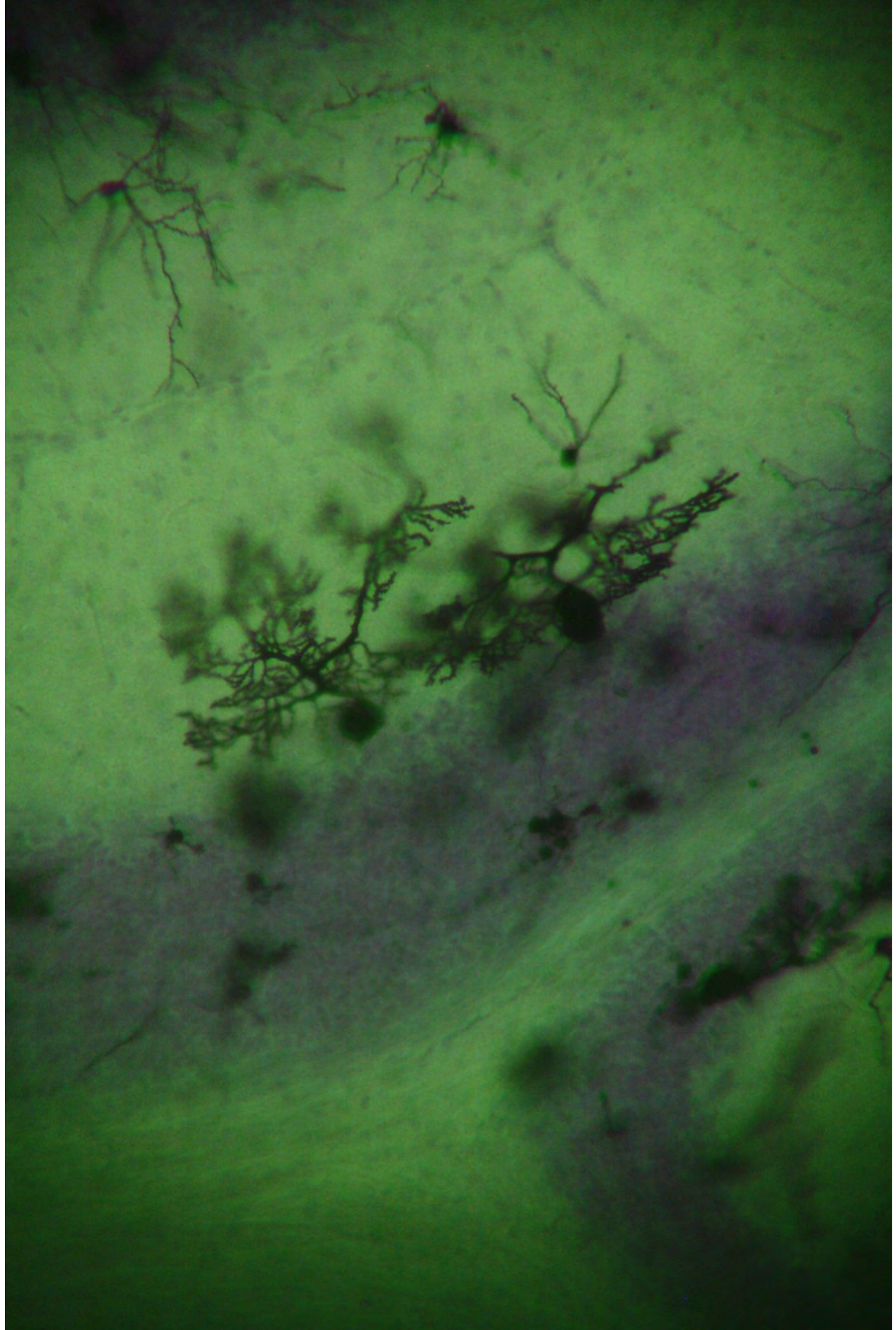


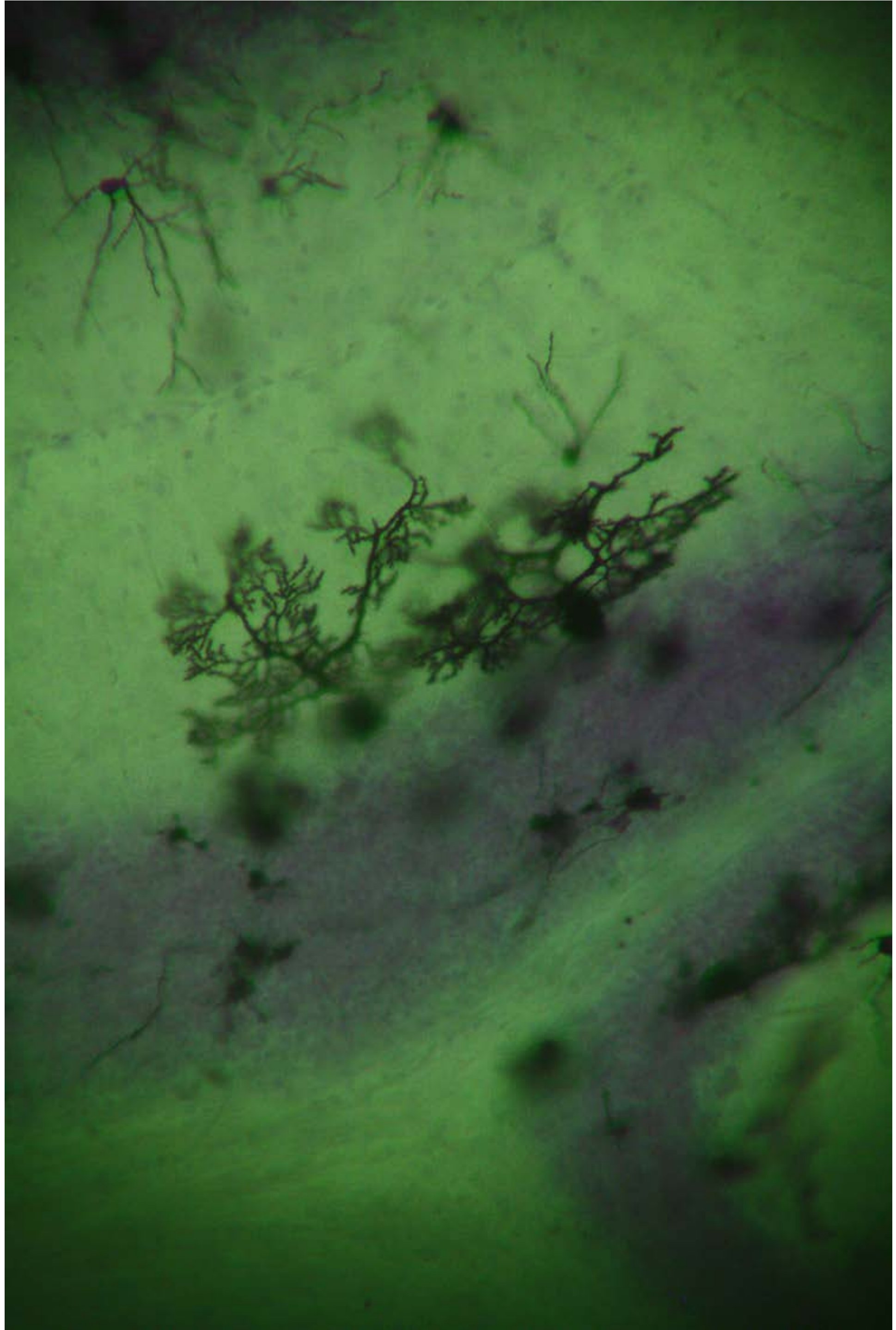
Pukinje cells, cerebellum, stained with Golgi method. Ramon y Cajal, 1888

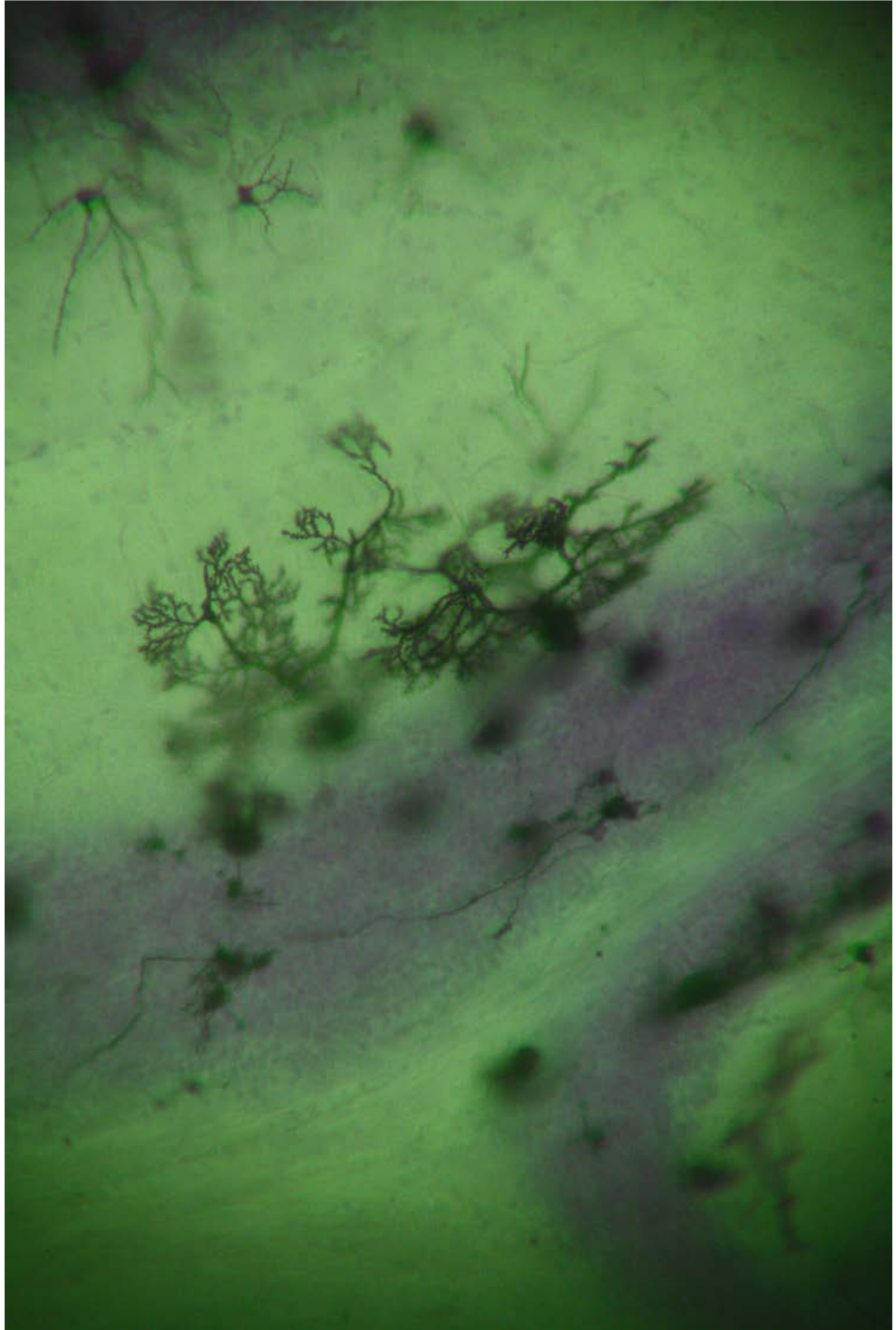
Now follows a series of Purkinje cells from the cerebellum of rats stained by my tutor Bolek Srebro

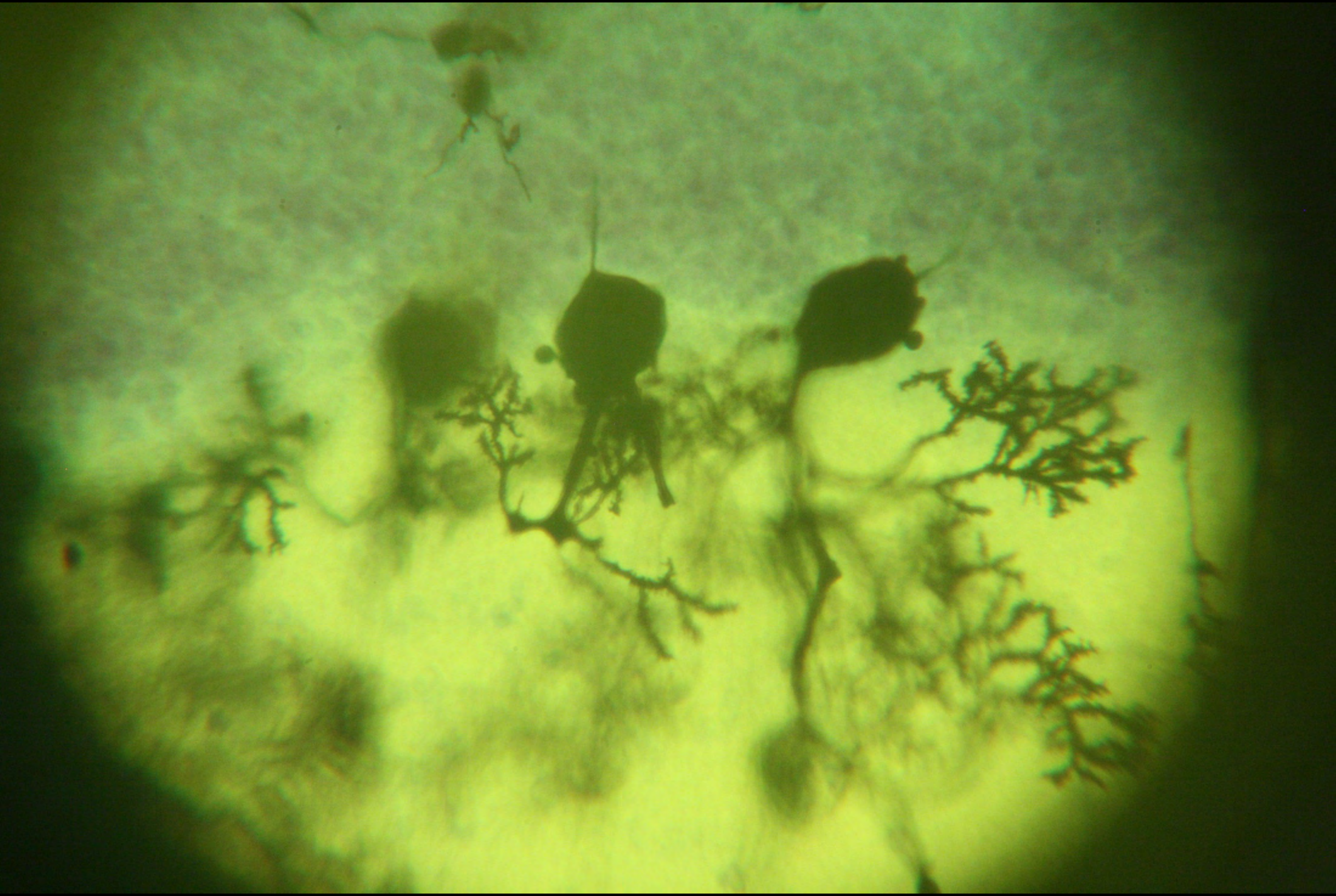


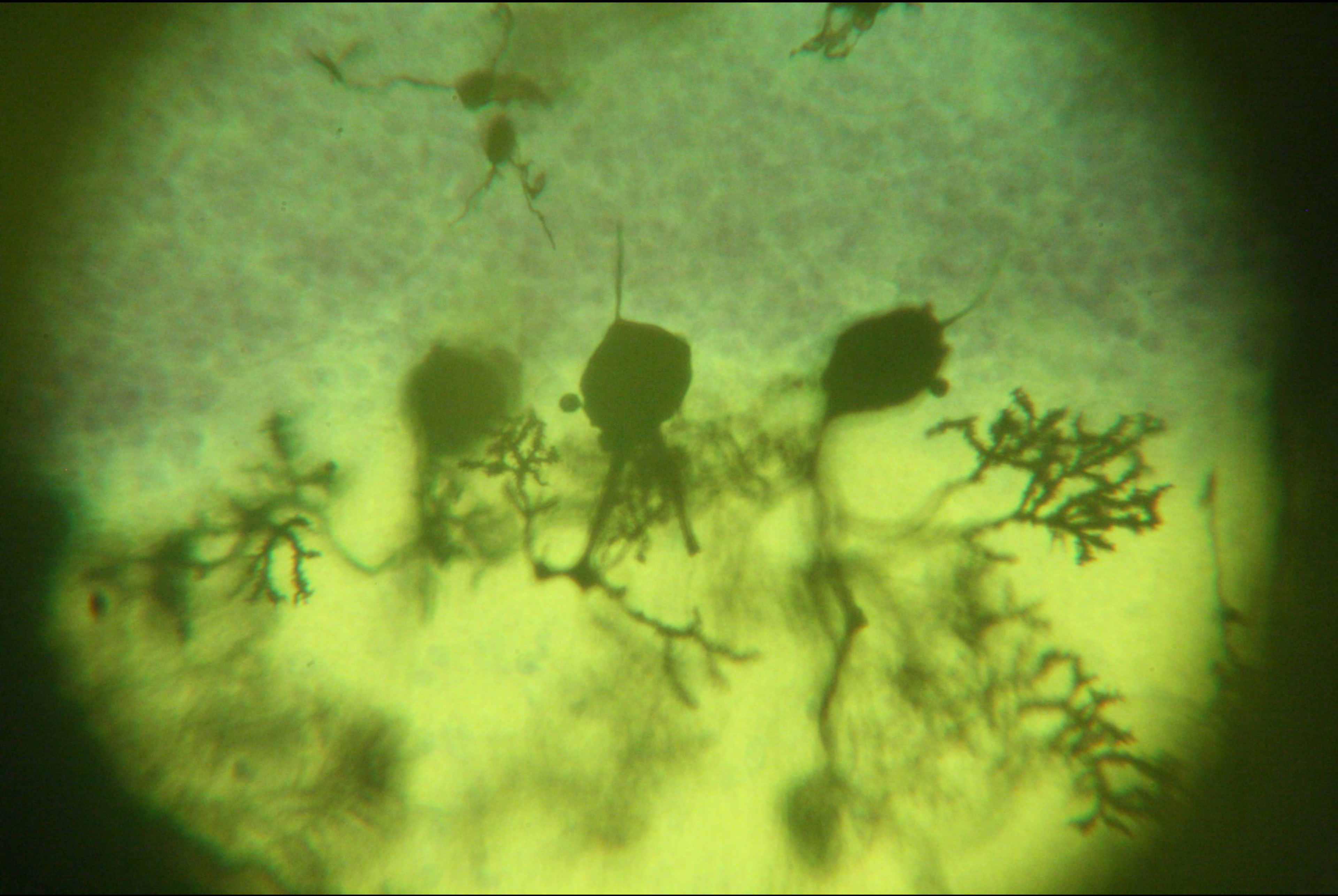


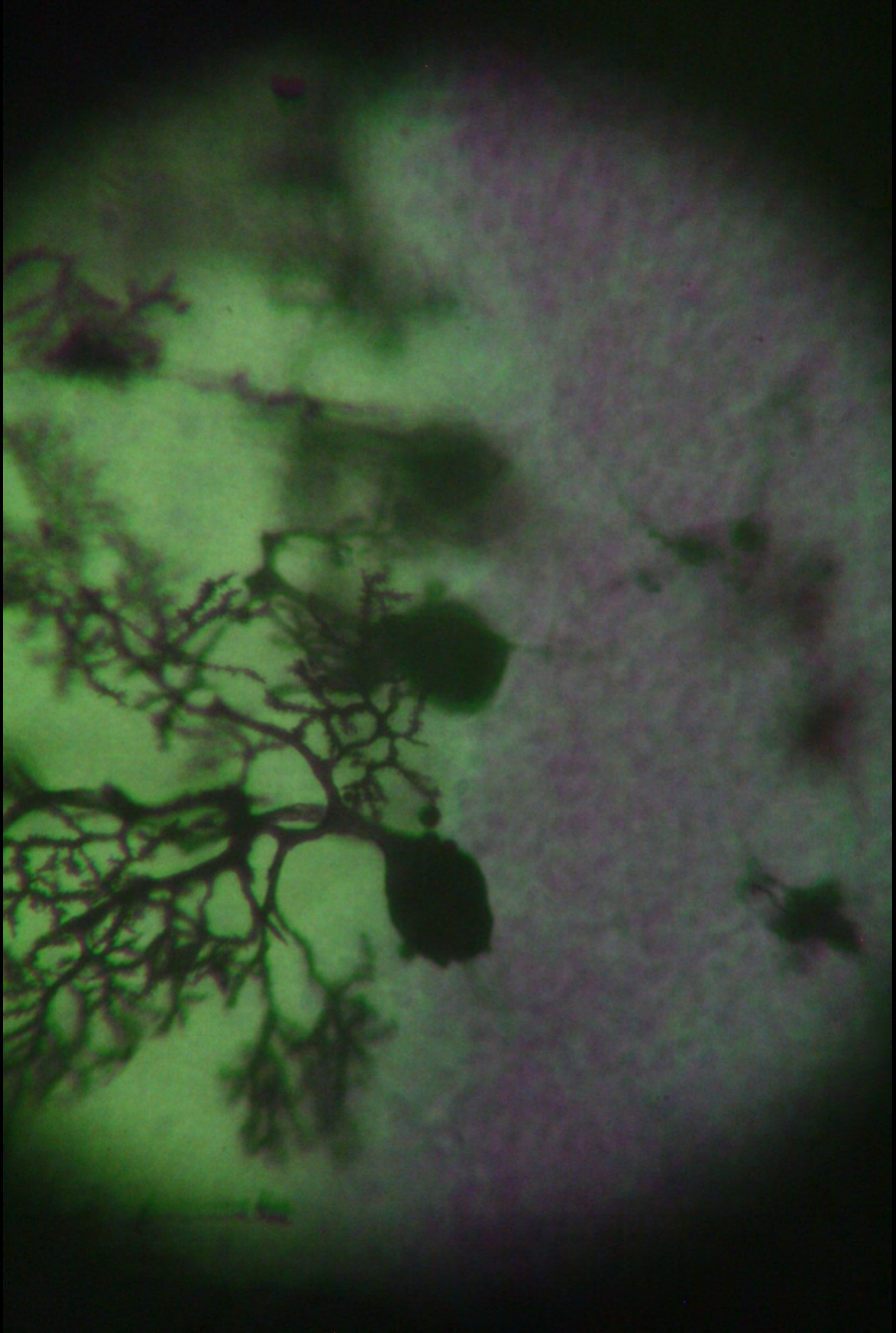


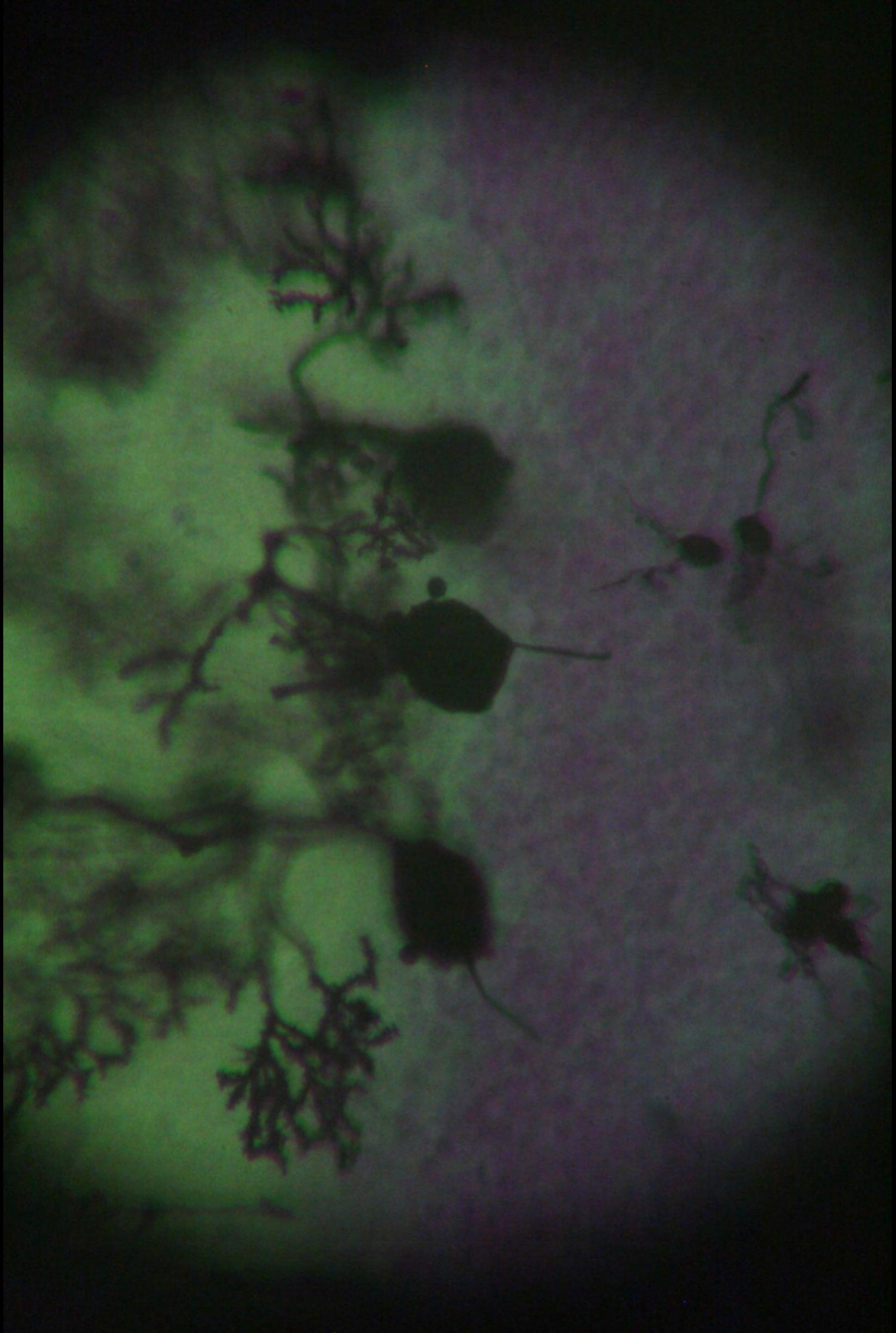


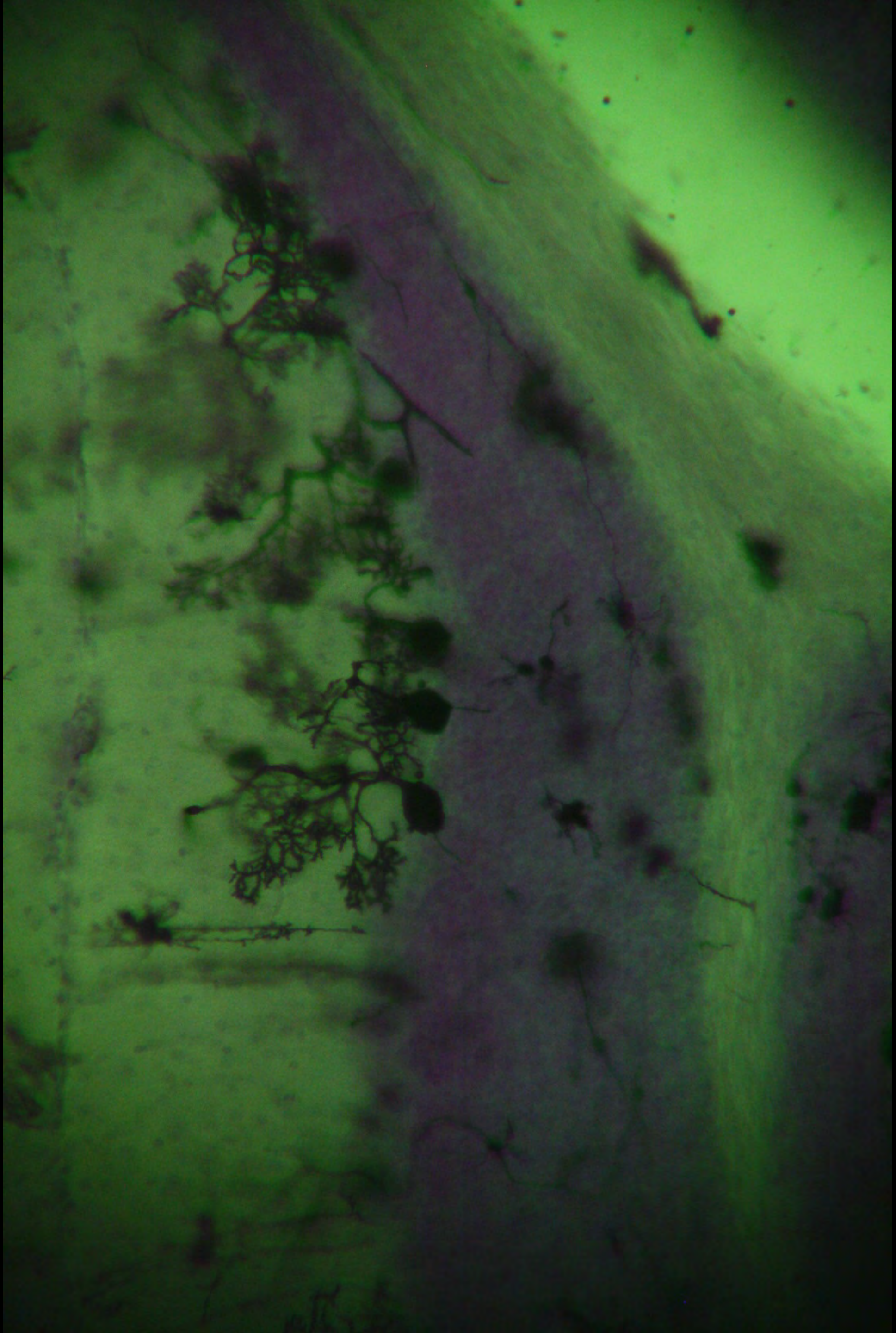


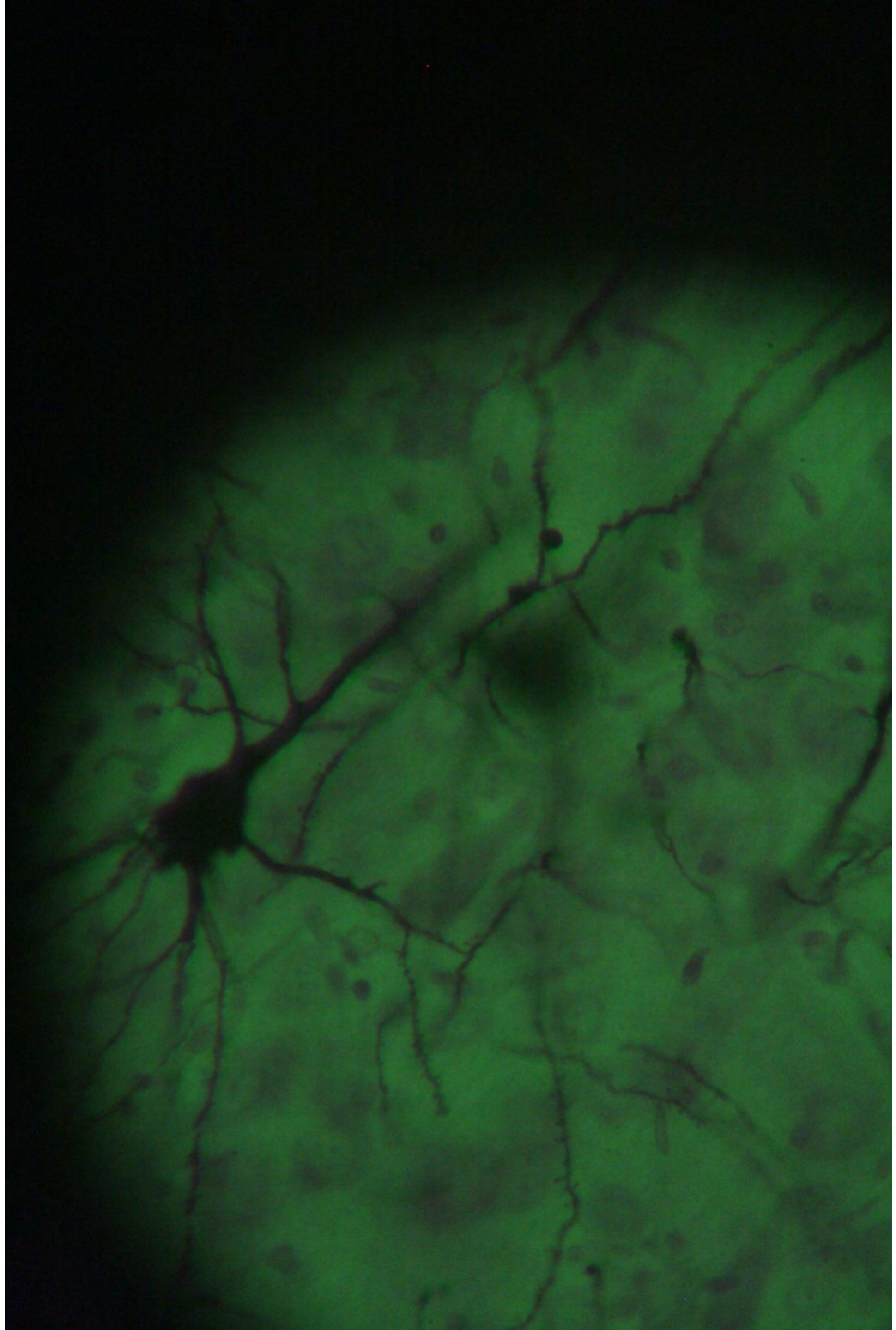


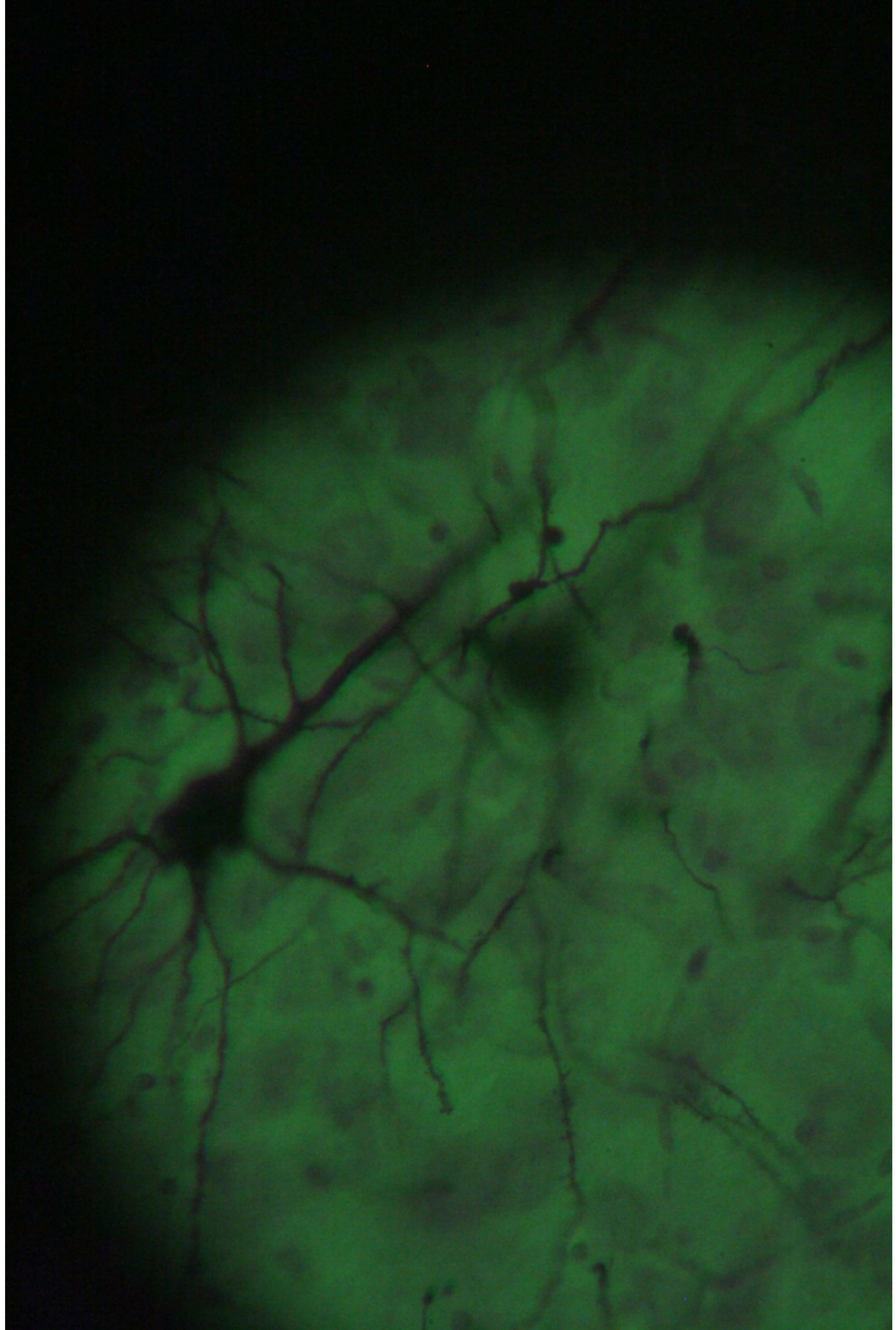


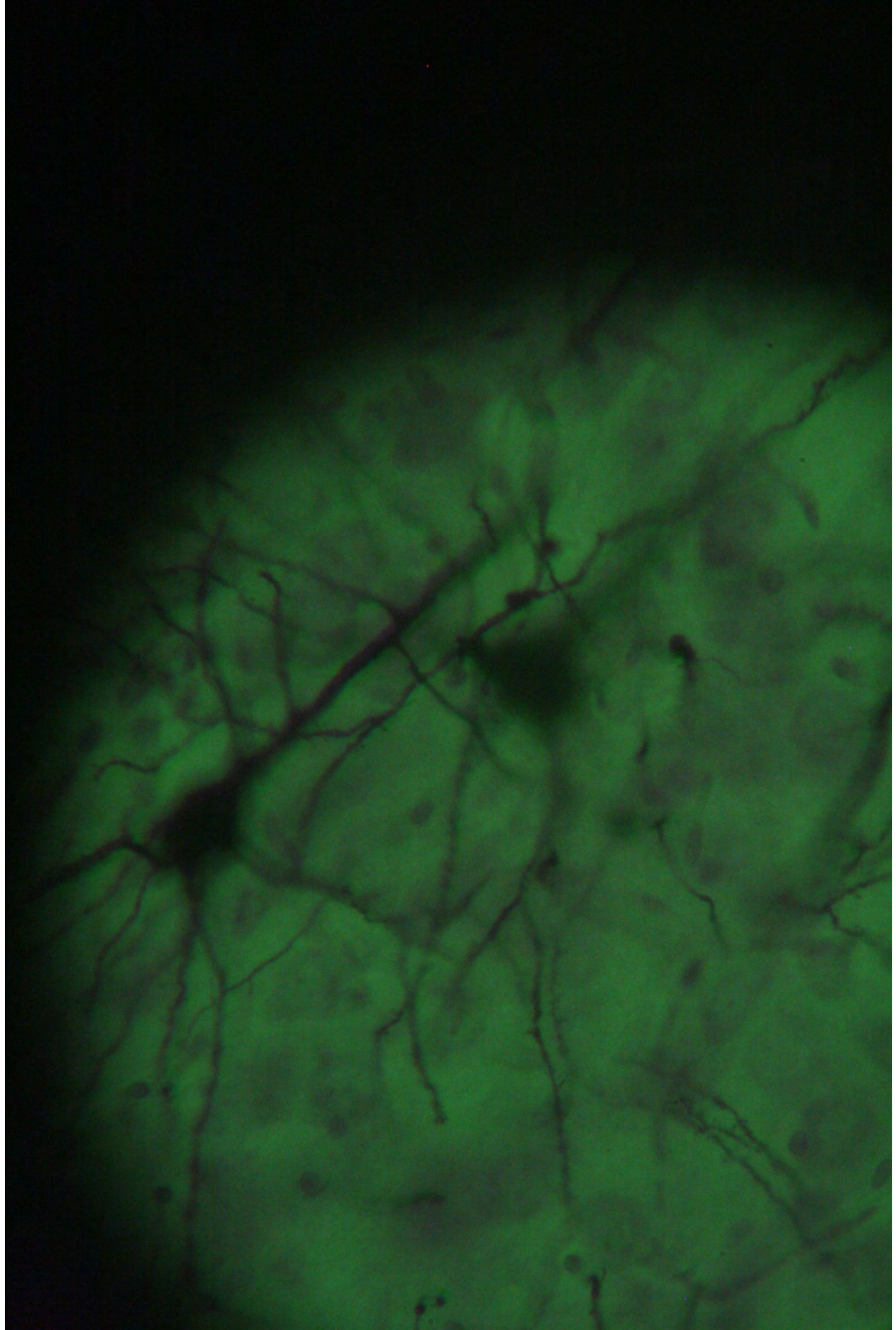


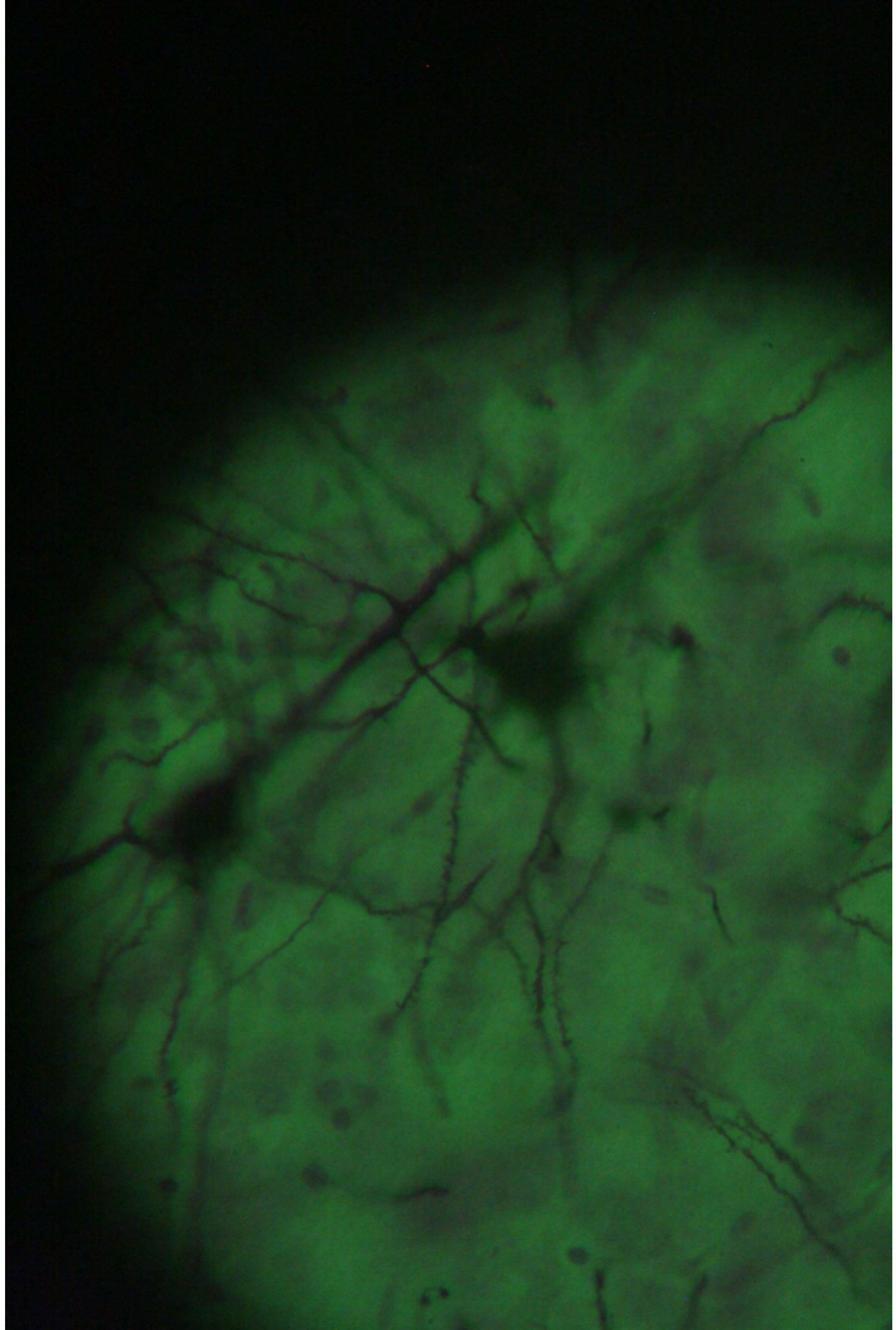


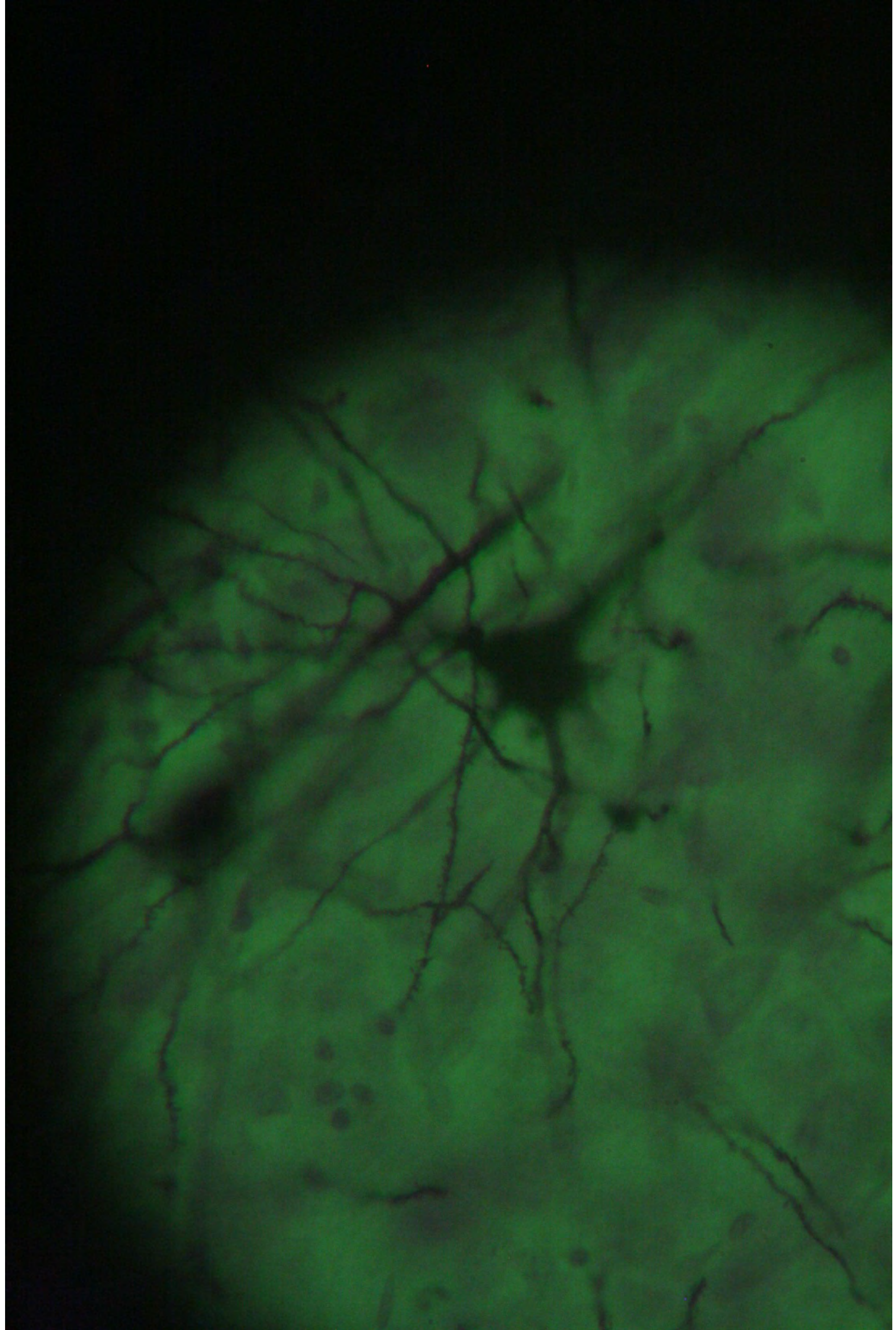


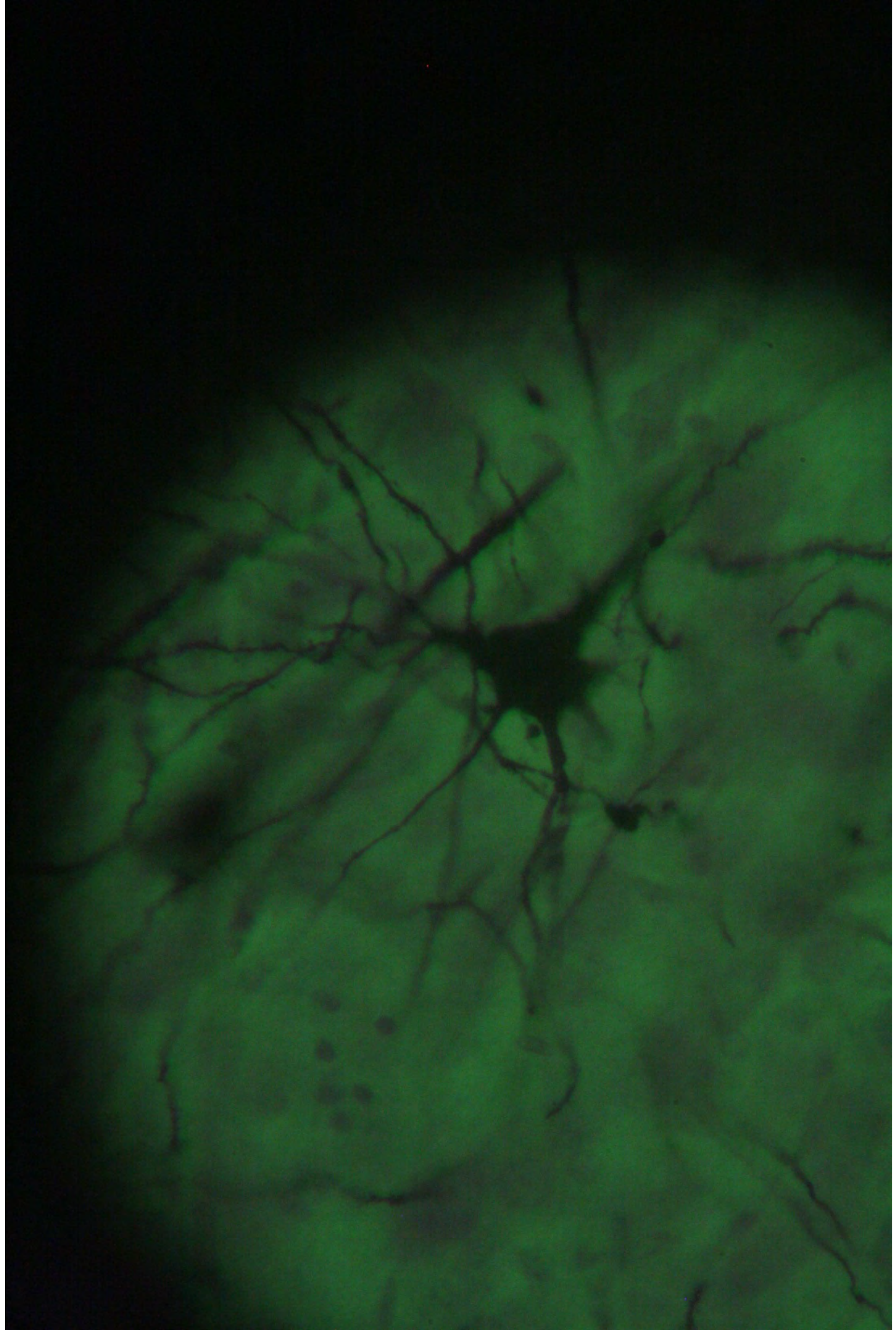


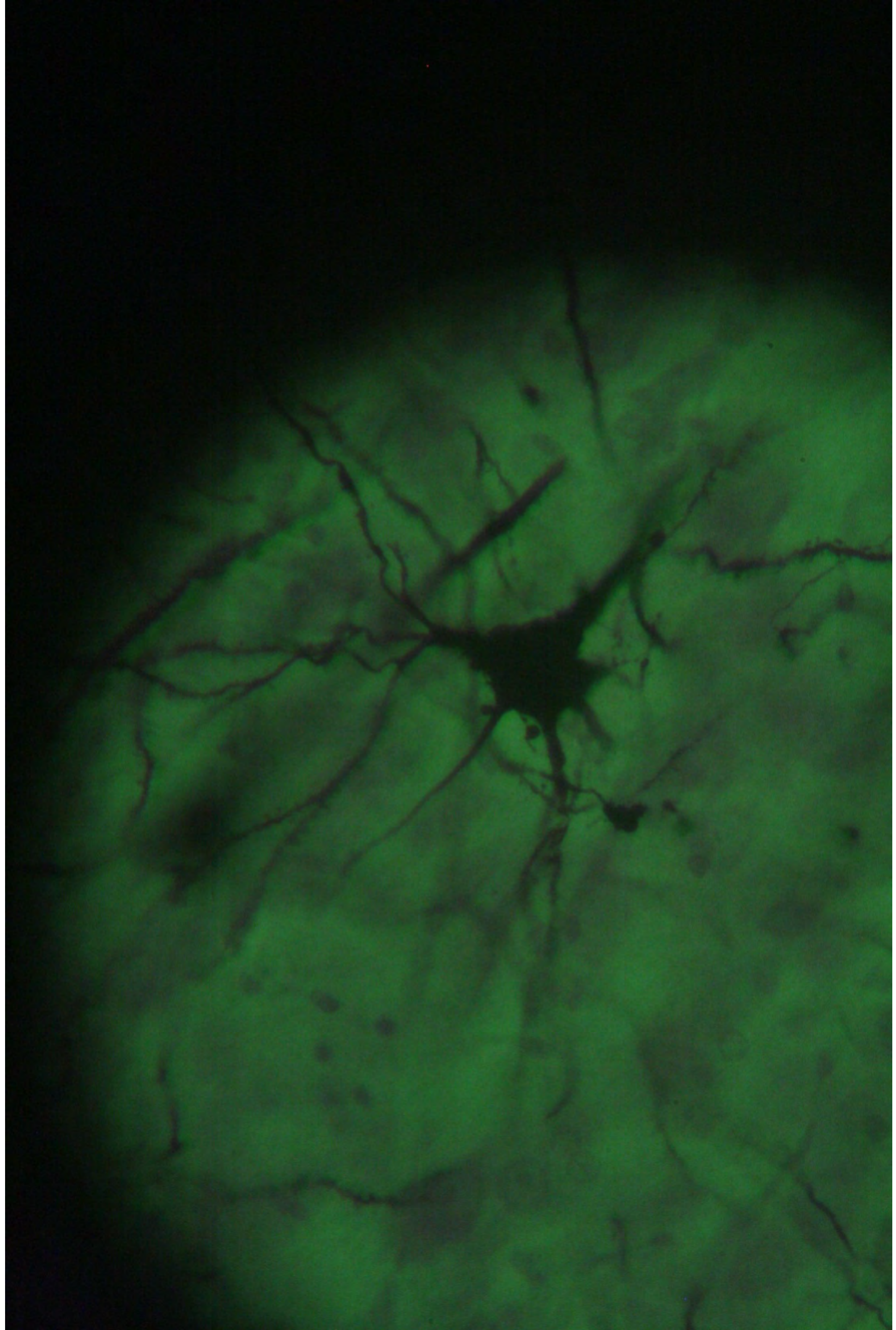


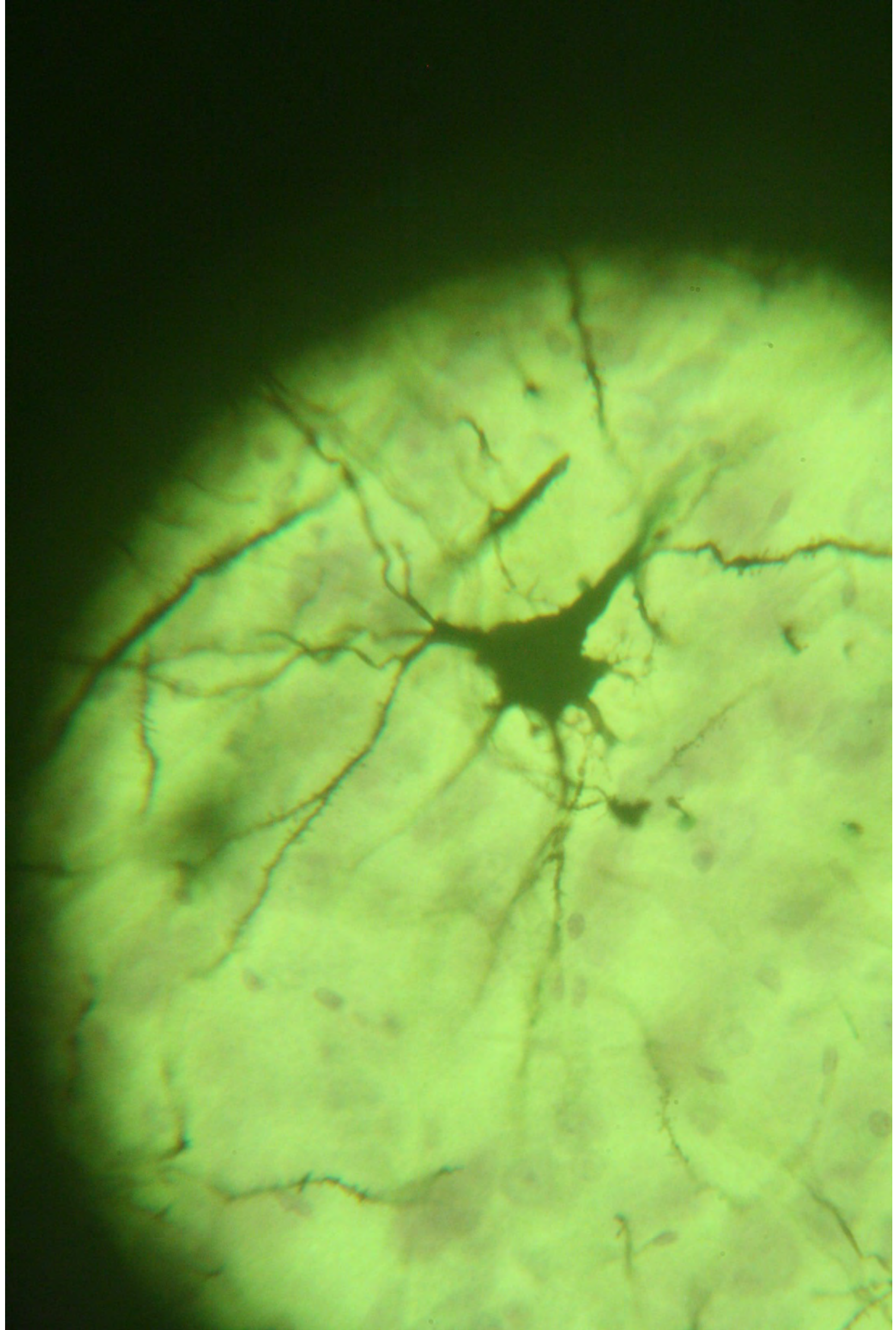


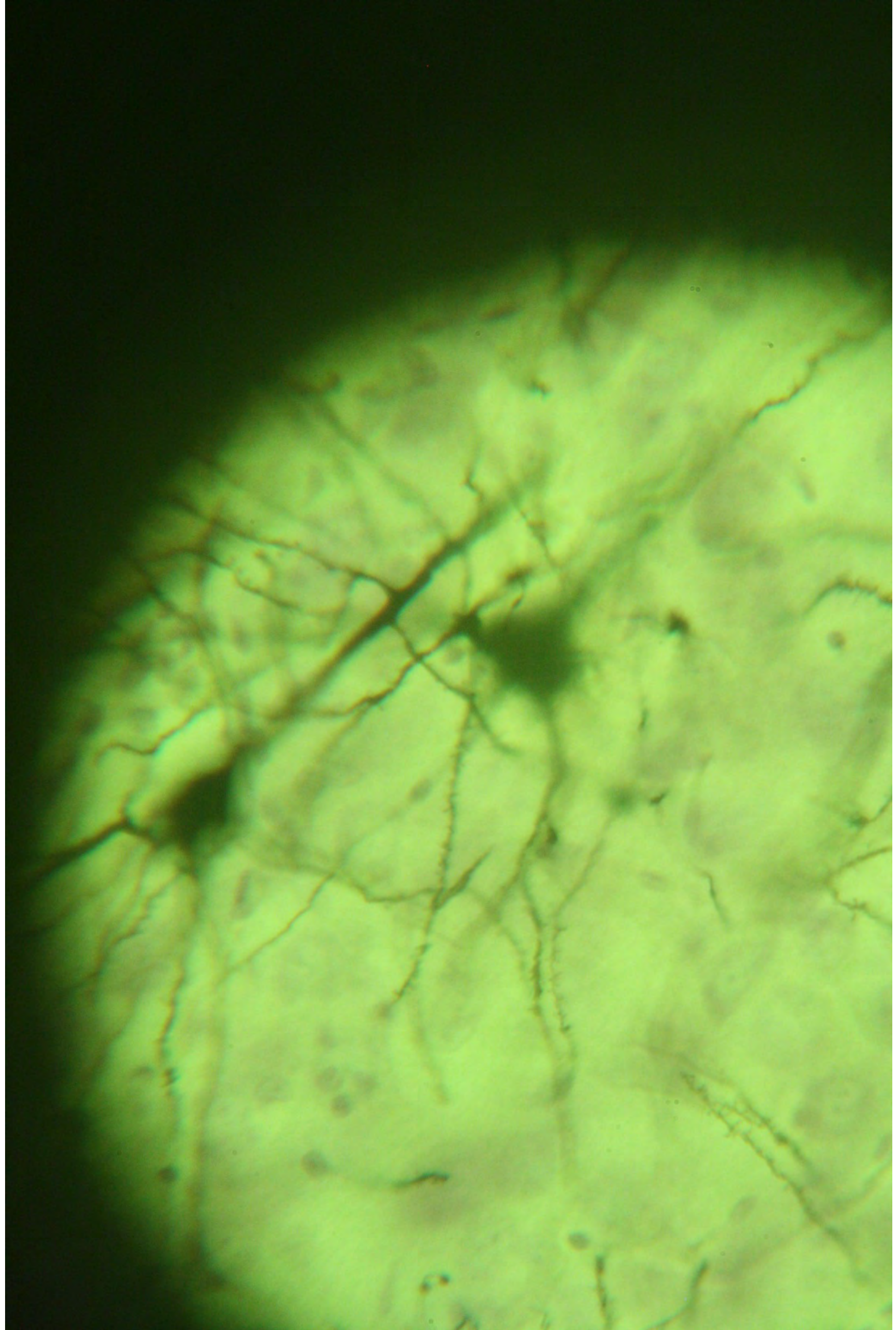


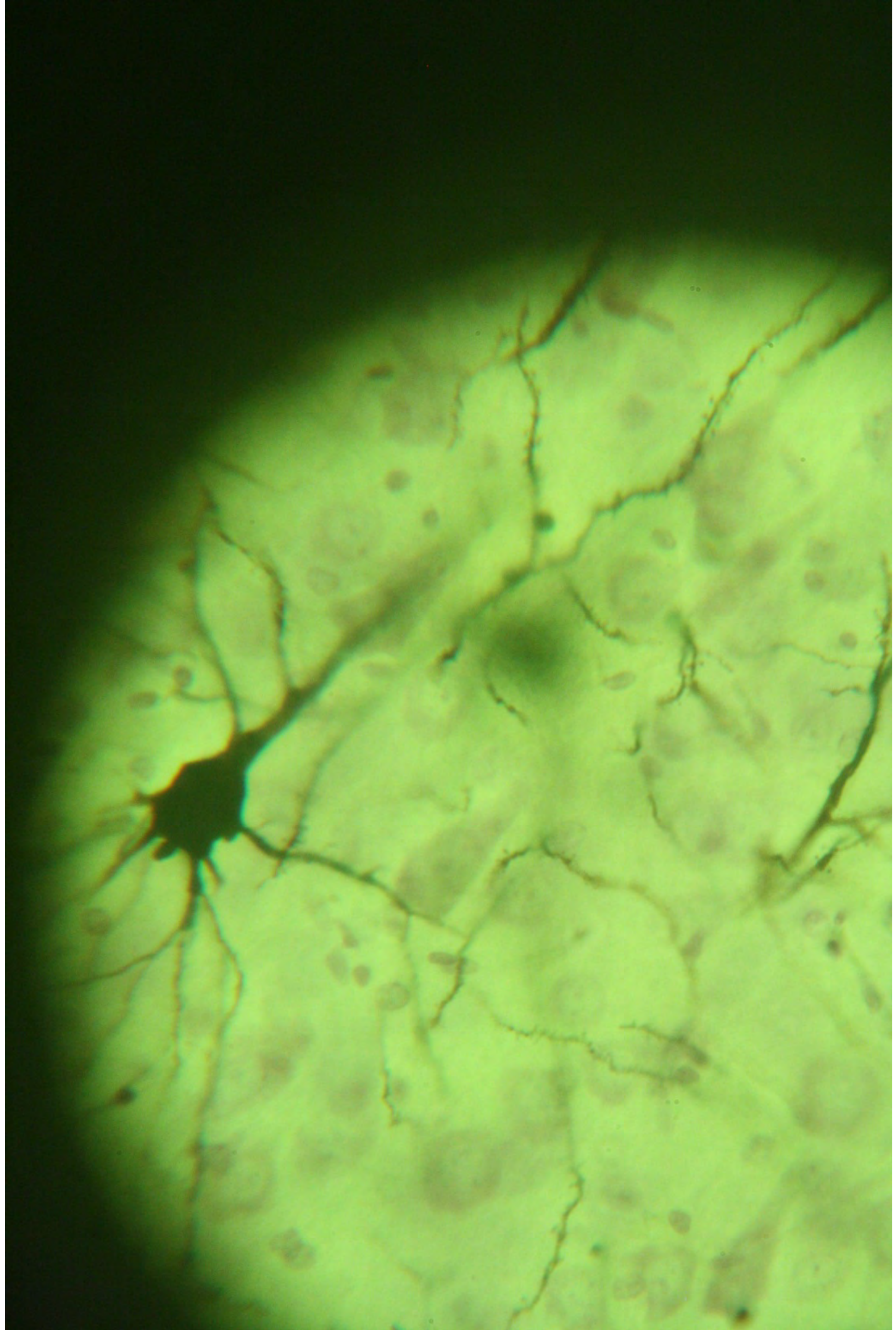


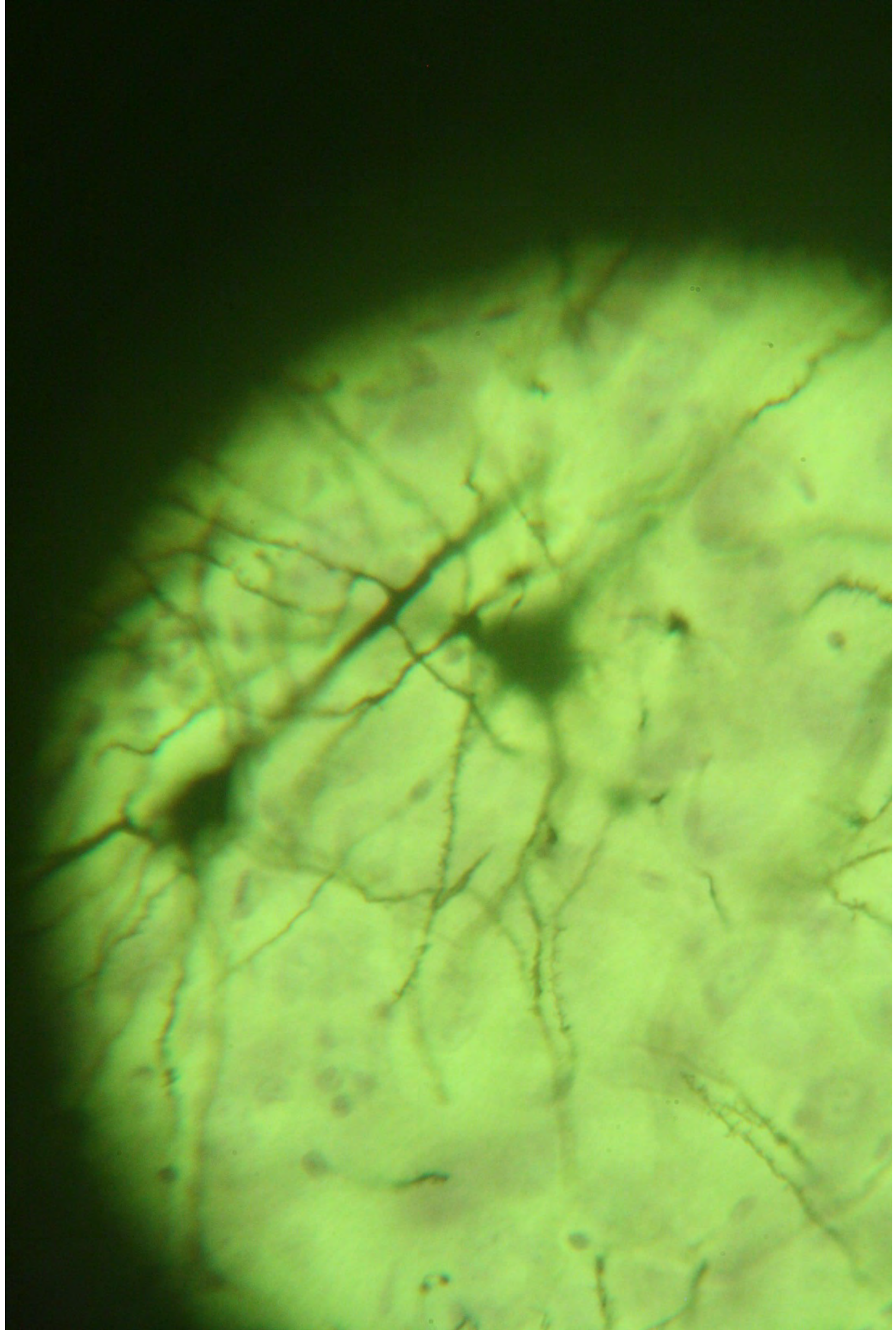


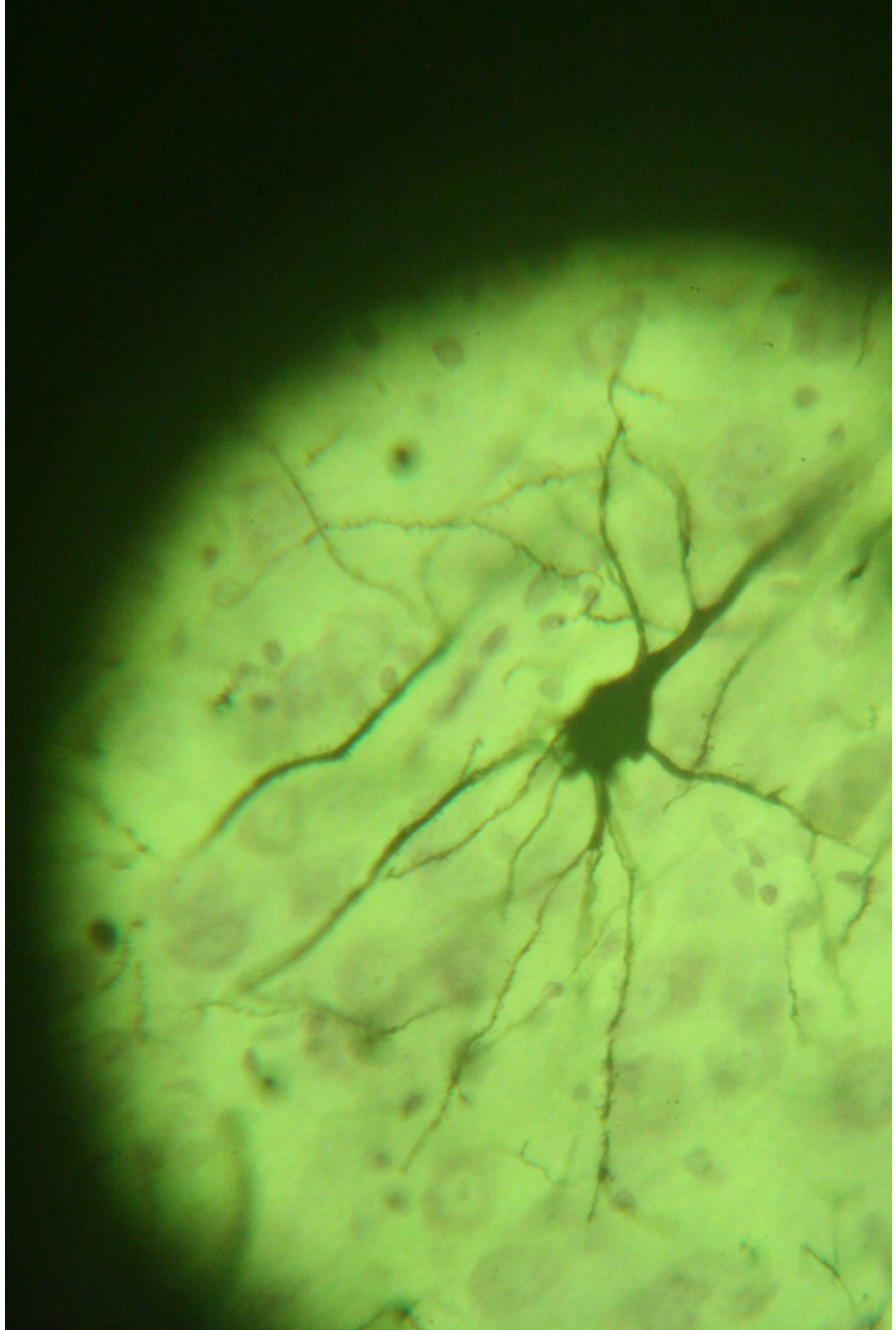


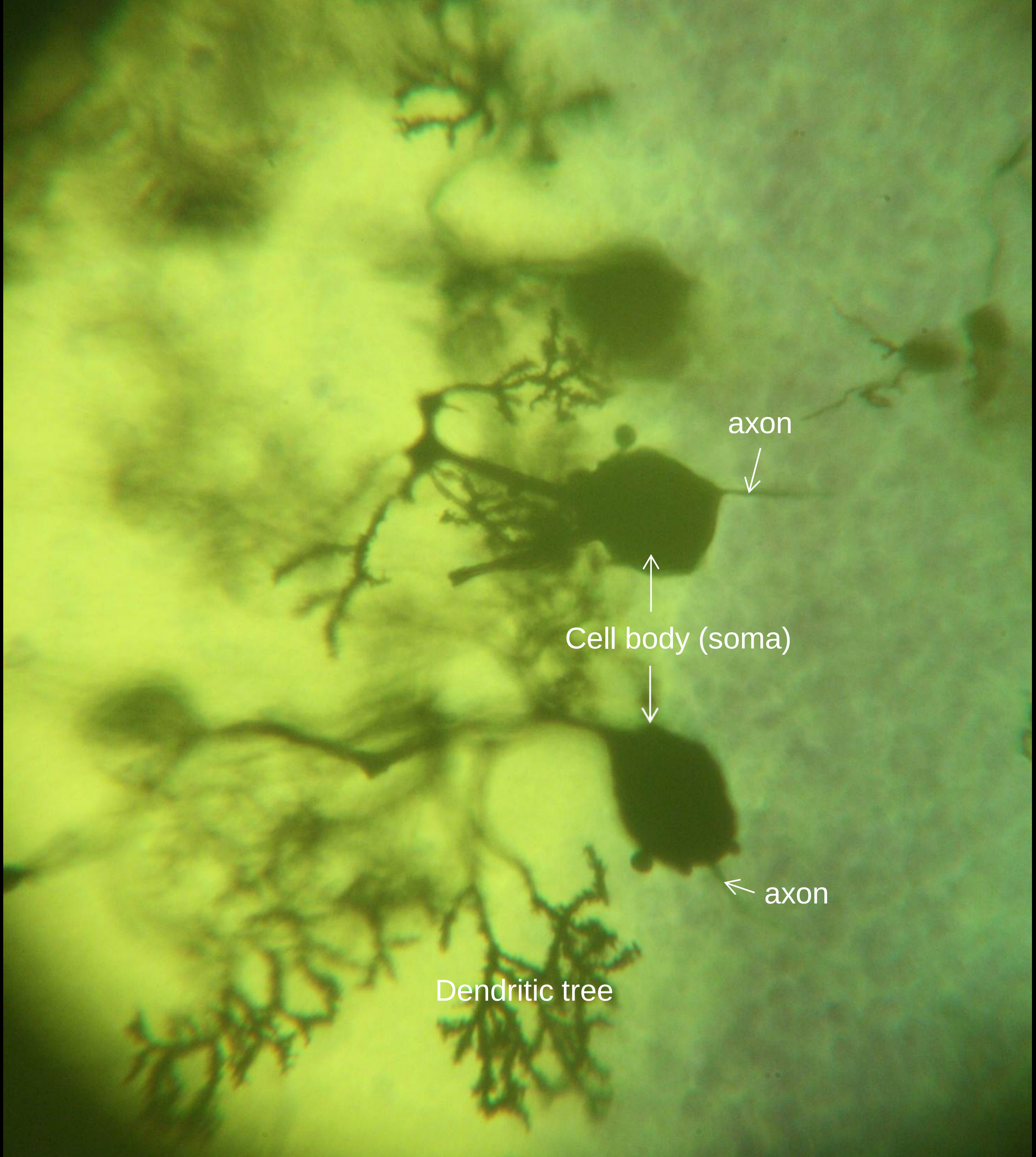


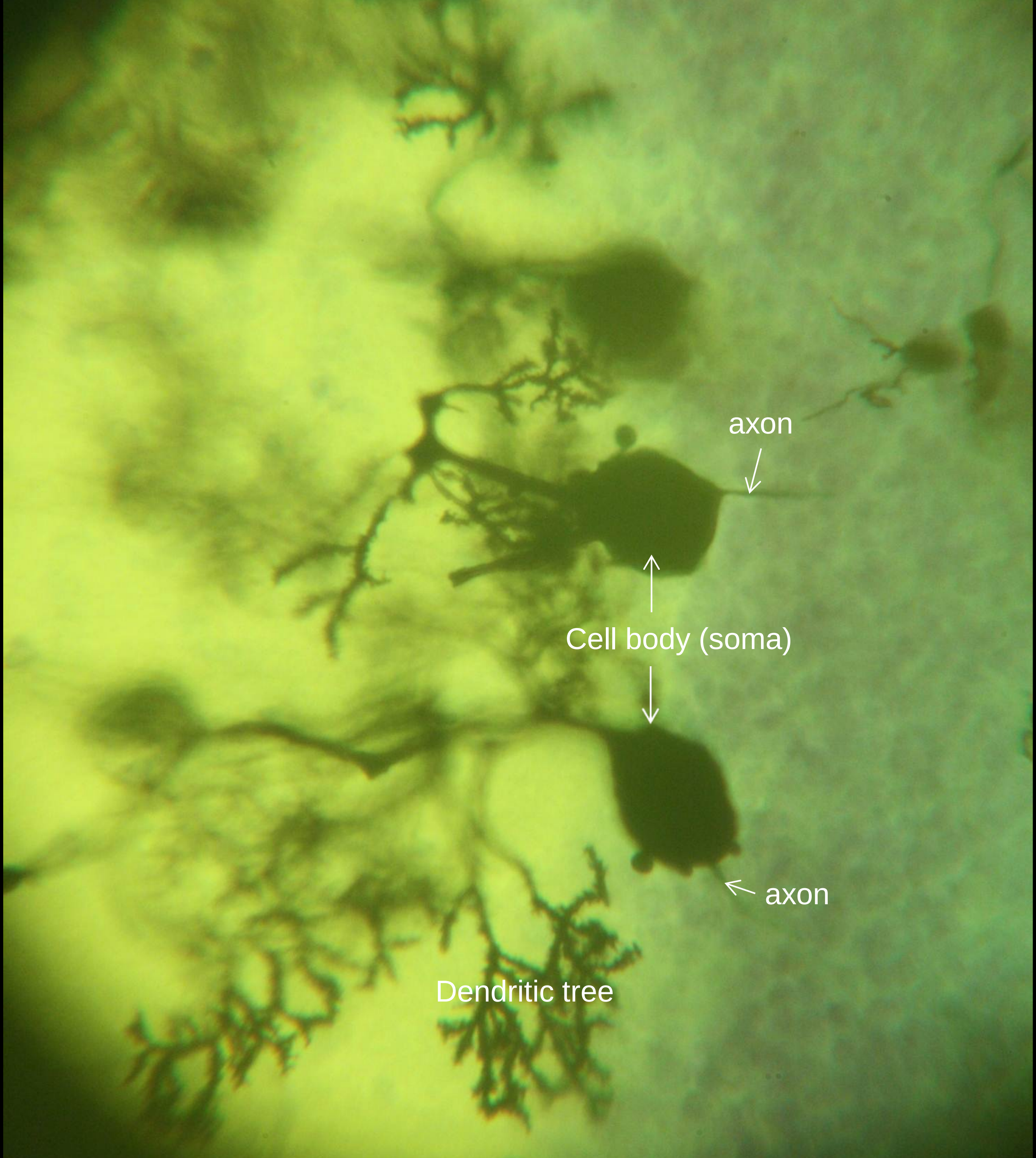


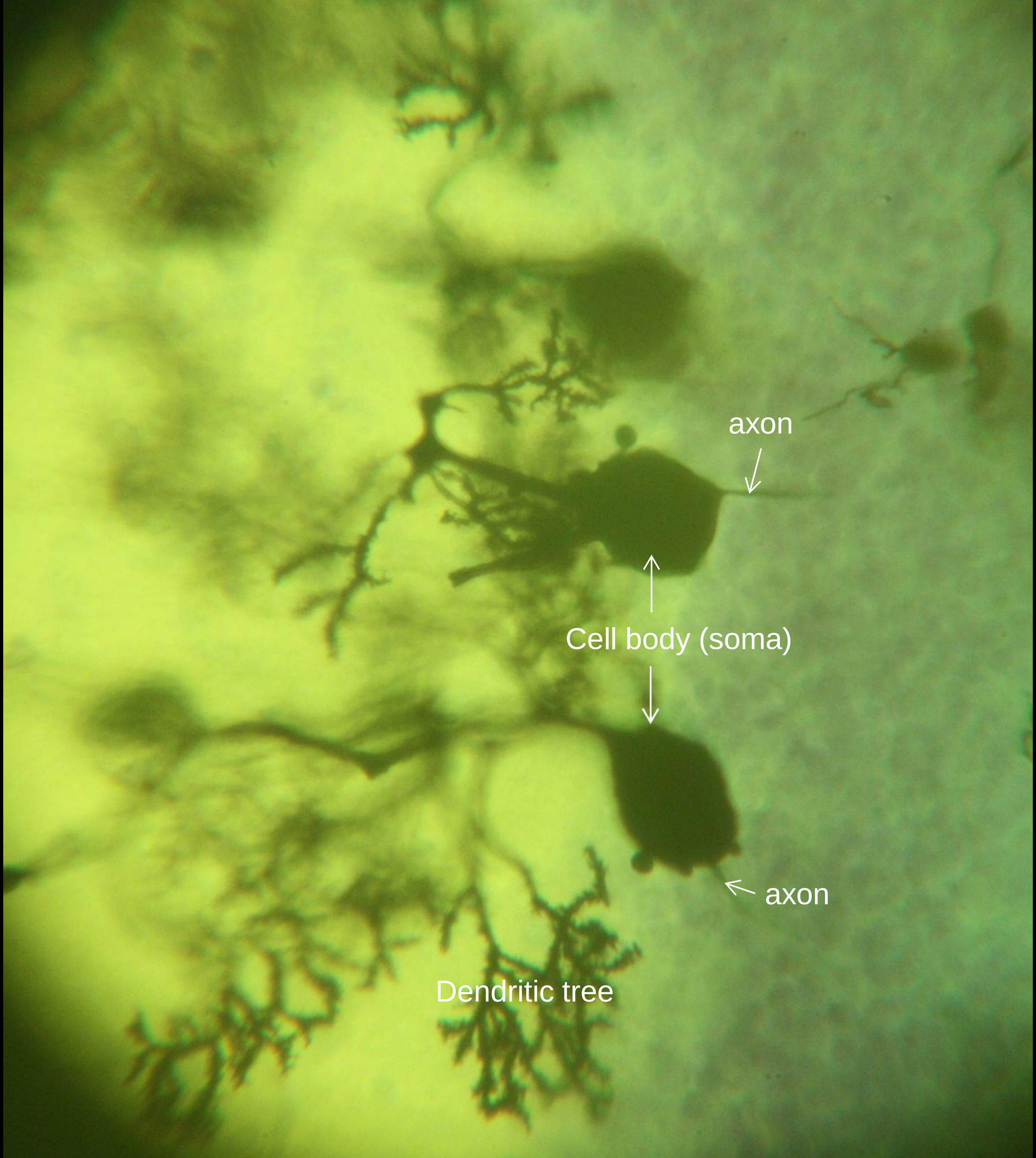


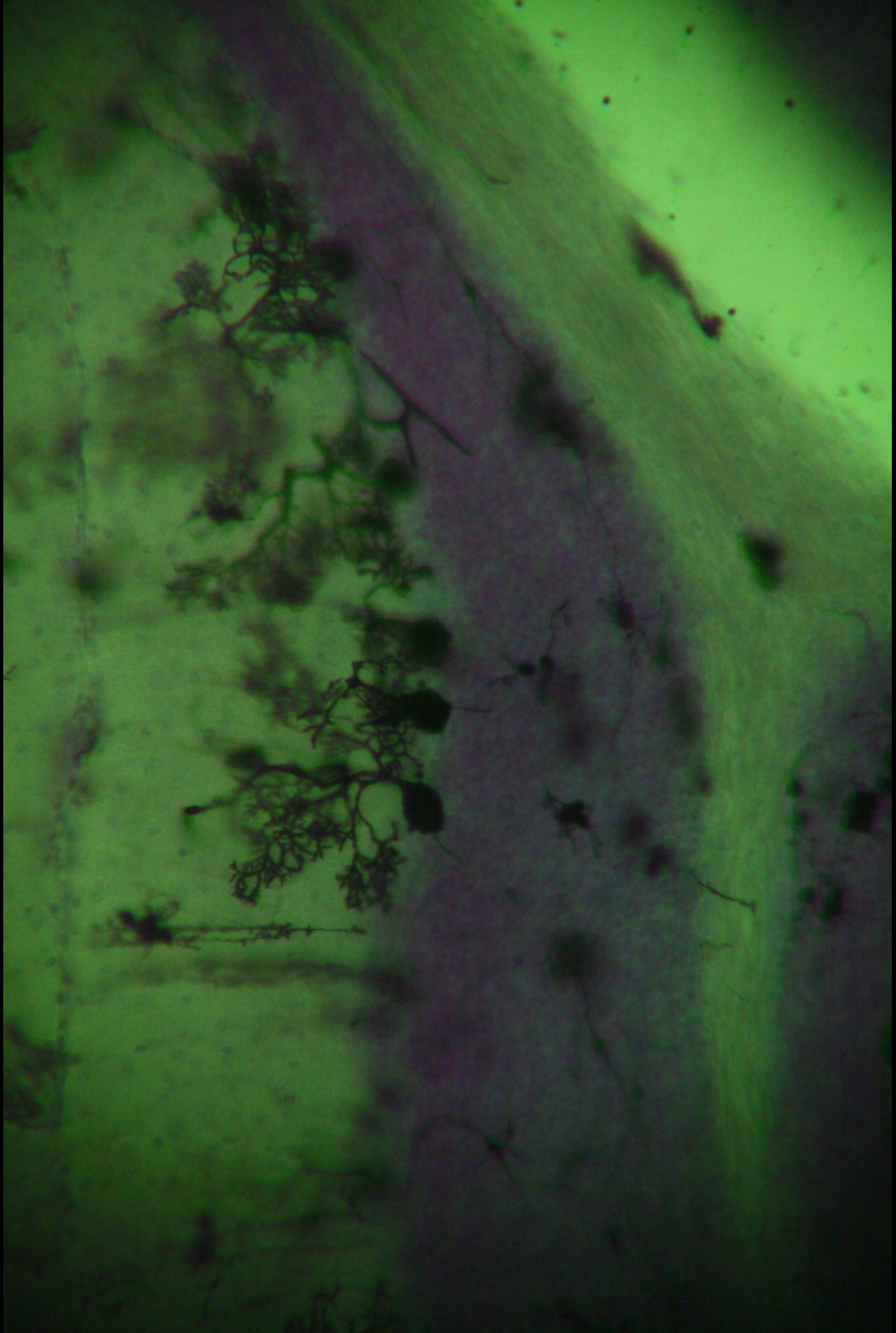


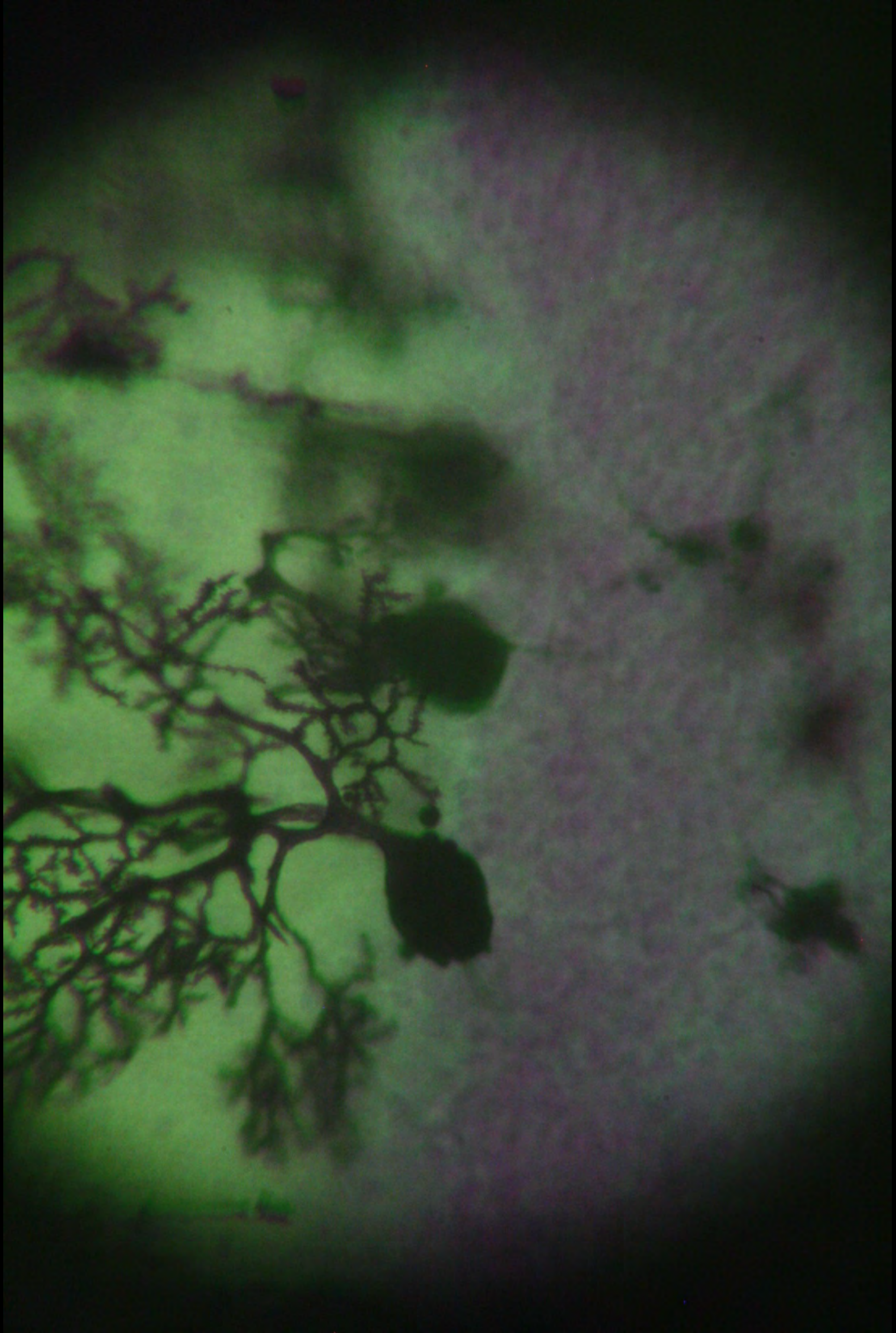


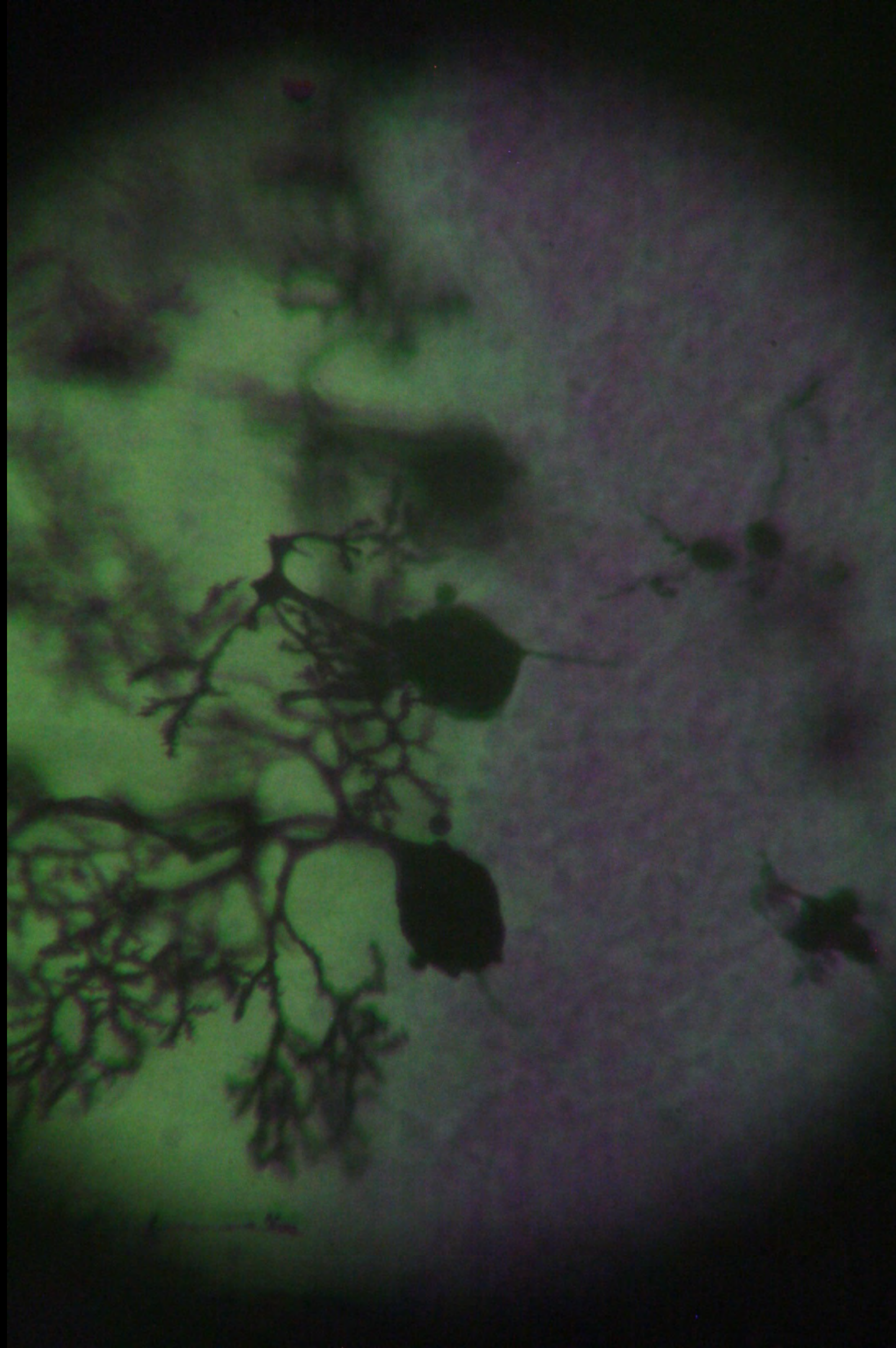

axon
Cell body (soma)
axon
Dendritic tree

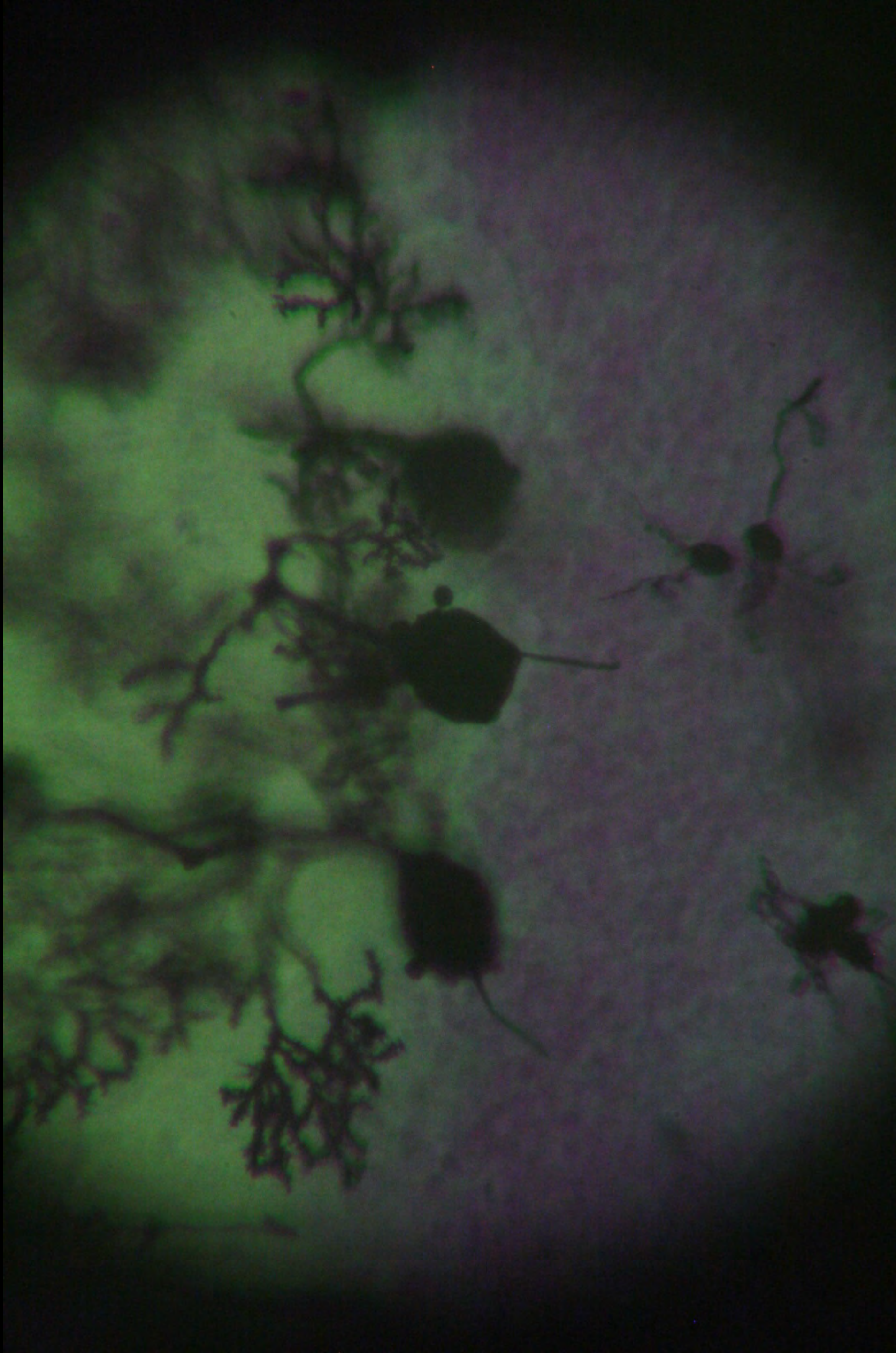

axon
Cell body (soma)
axon
Dendritic tree

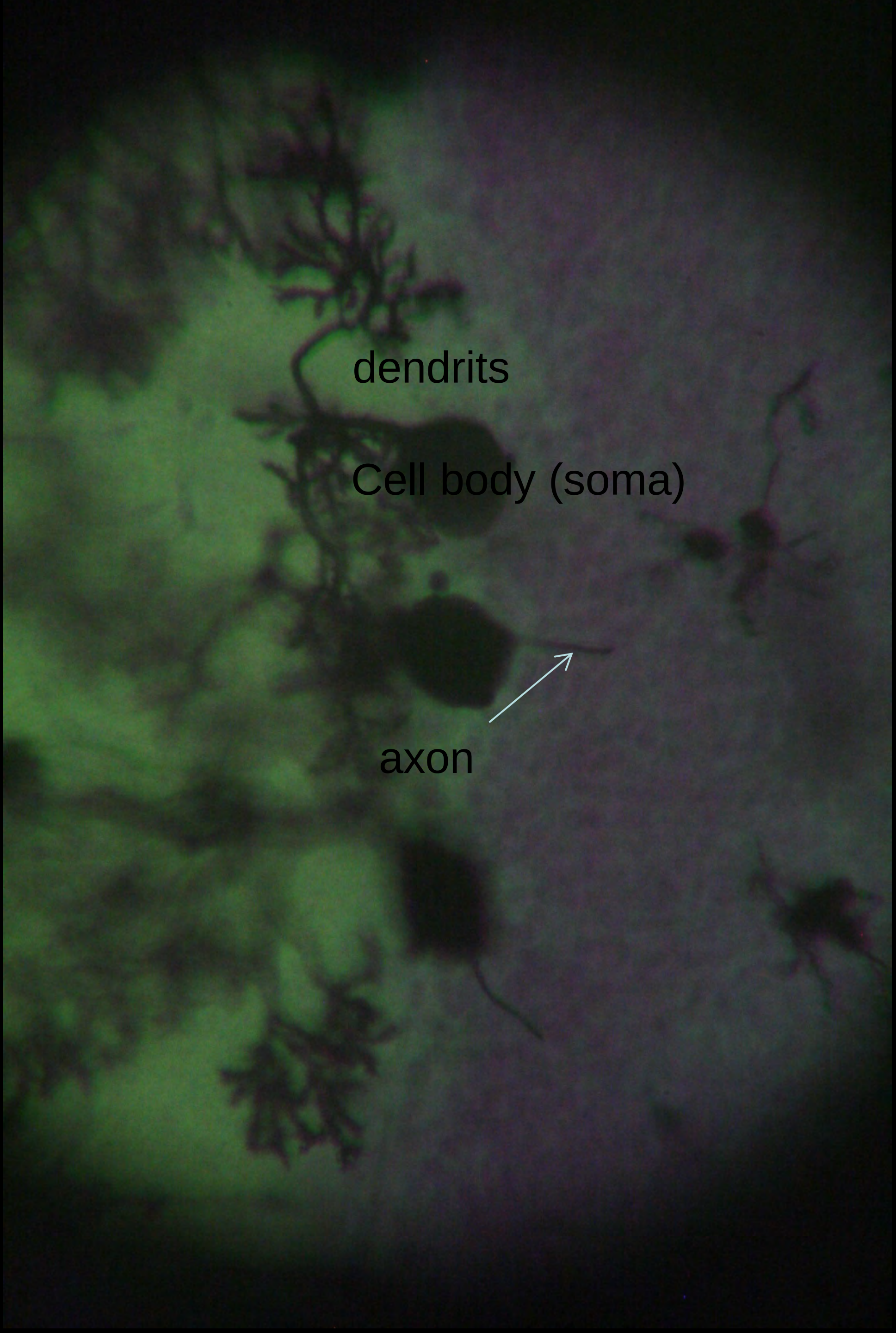

axon
Cell body (soma)
axon
Dendritic tree

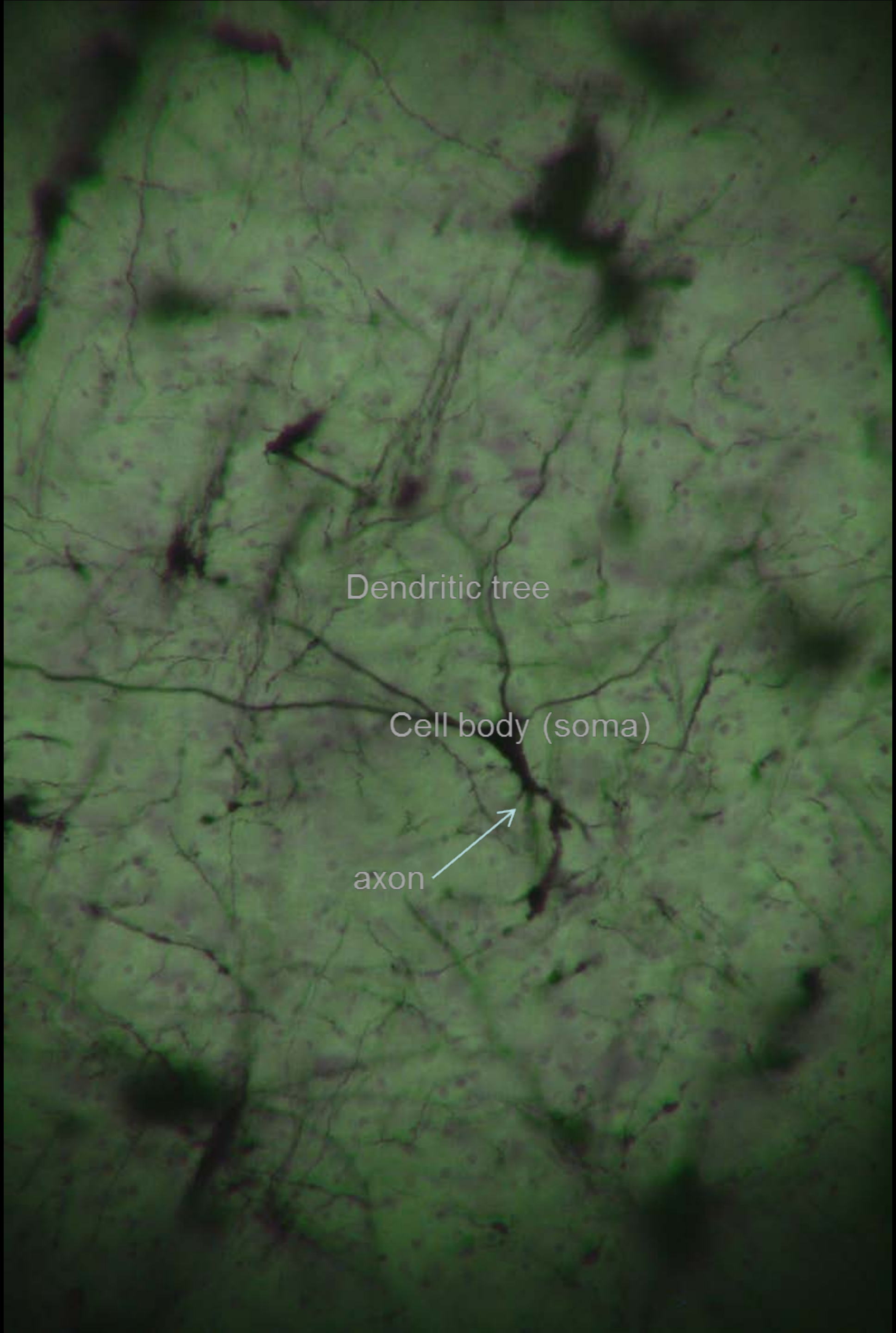


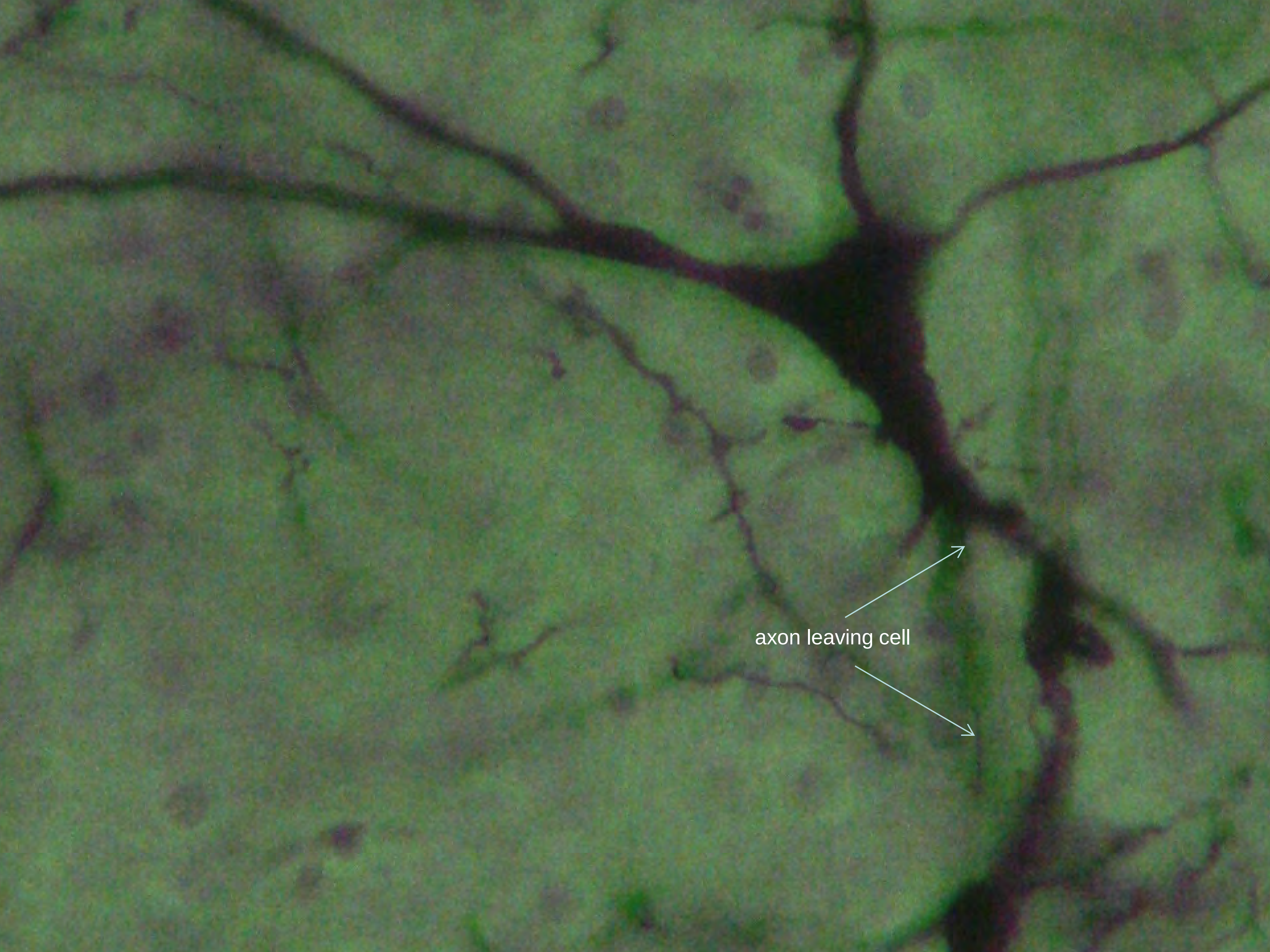


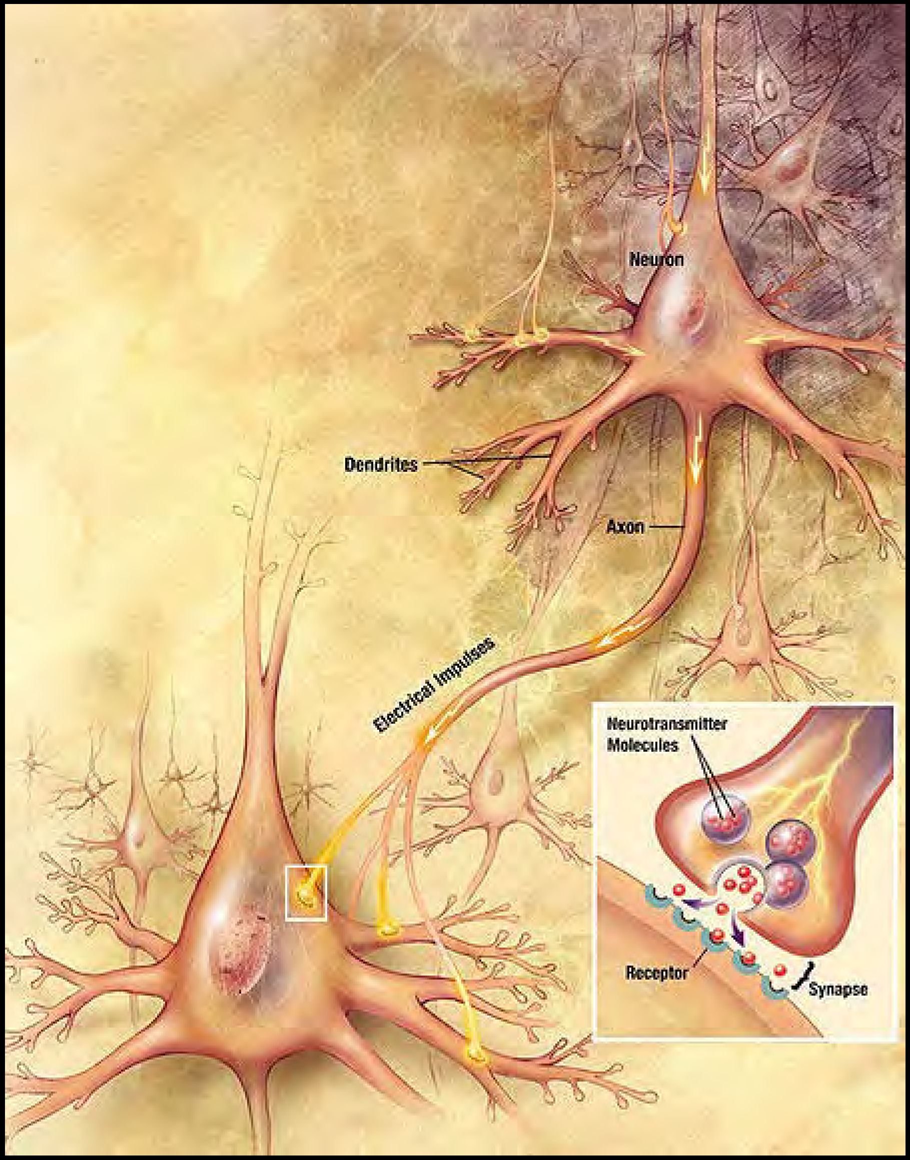


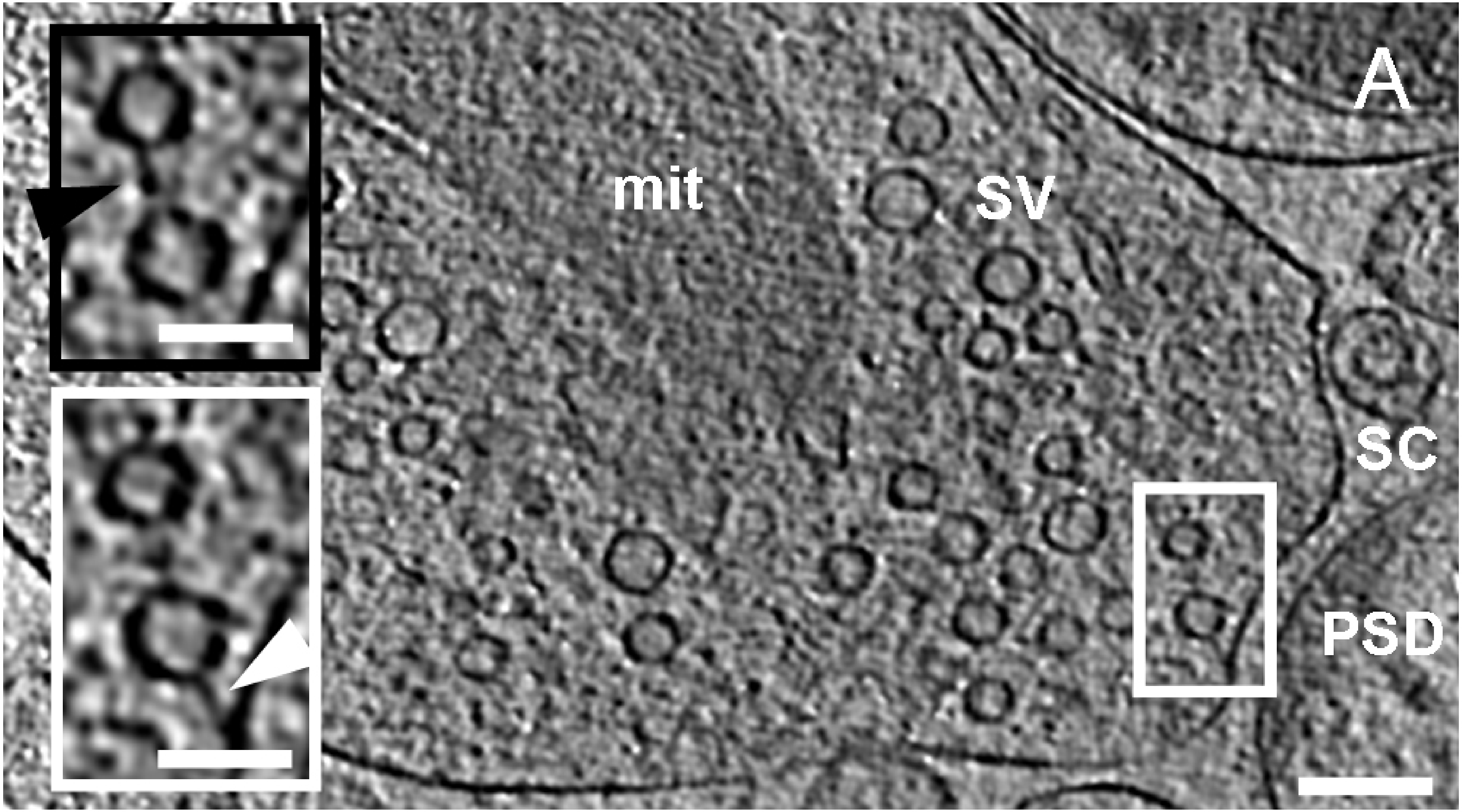



dendrits
Cell body (soma)
axon

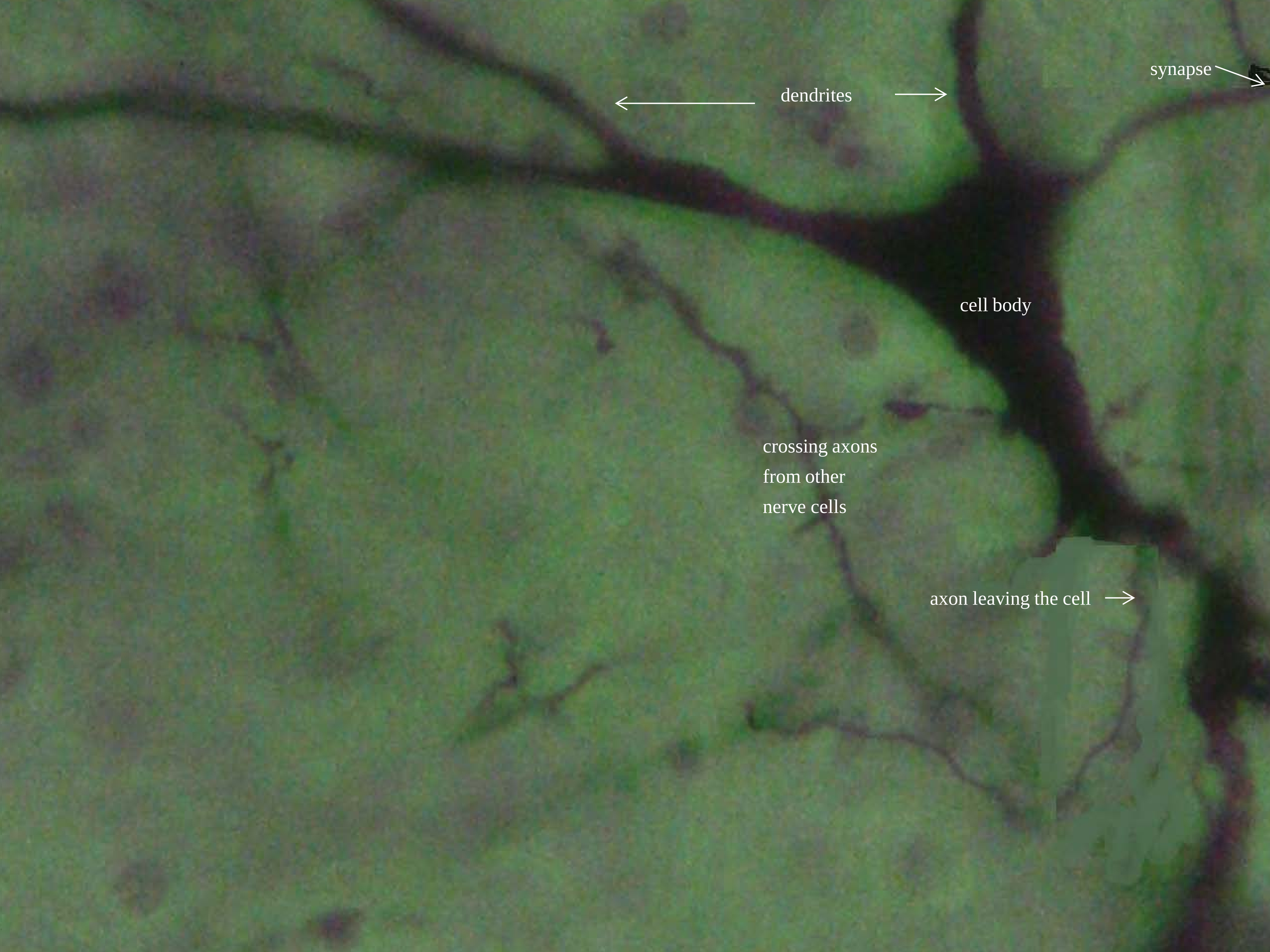

Dendritic tree
Cell body (soma)
axon

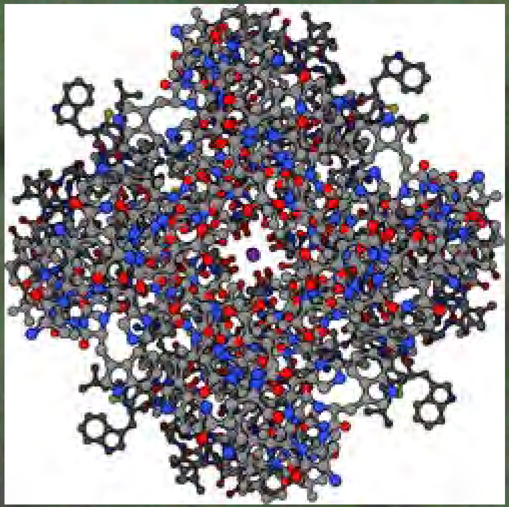

axon leaving cell


Neuron
Dendrites
Axon
Electrical Impulses
Neurotransmitter Molecules
Receptor
Synapse

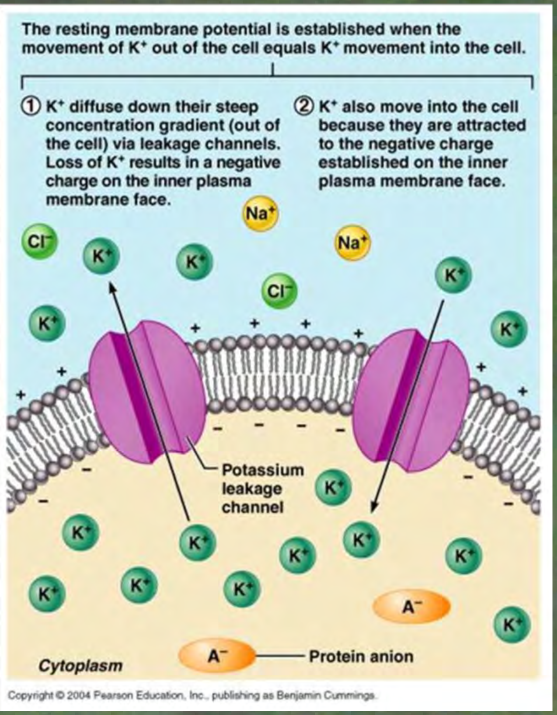


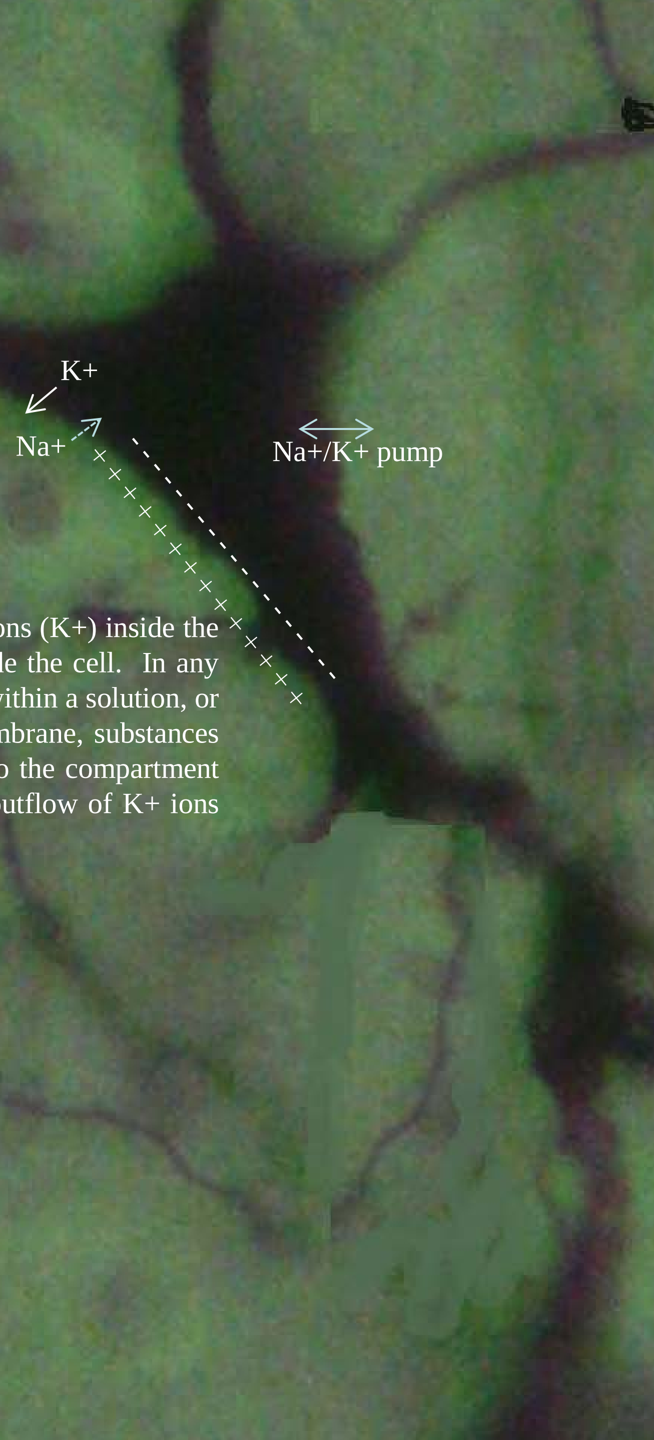
SV	synaptic vesicles
SC	synaptic cleft
PSD	postsynaptic dendrit
Mit	mitochondrion


synapse
dendrites
cell body
crossing axons
from other
nerve cells
axon leaving the cell

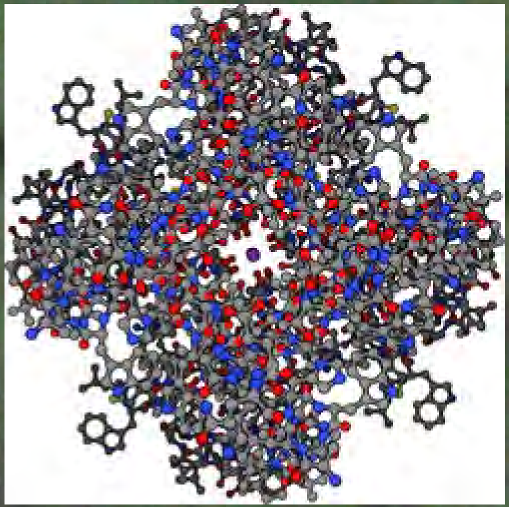


Potassium (K+) channel, protein structure

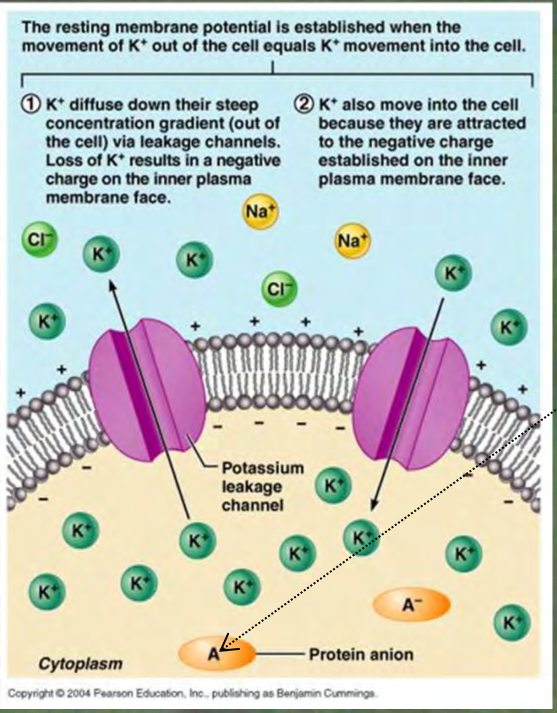


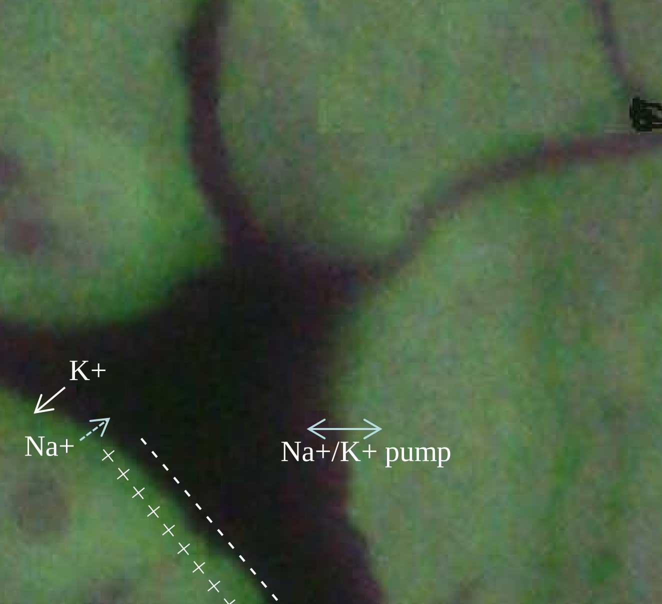


A nerve cell at rest has a high concentration of potassium ions (K+) inside the cell, and a high concentration of sodium ions (Na+) outside the cell. In any chemical system where there is a concentration difference within a solution, or between two compartments separated by a permeable membrane, substances will diffuse from the compartment of high concentration to the compartment of low concentration. In the nerve cell this results in an outflow of K+ ions and an inflow of Na+ ions.



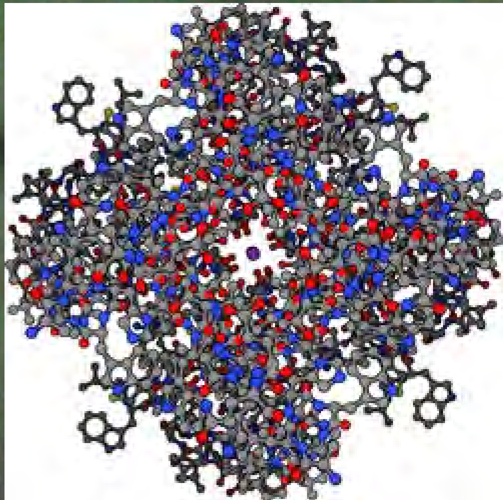
Potassium (K+) channel, protein structure



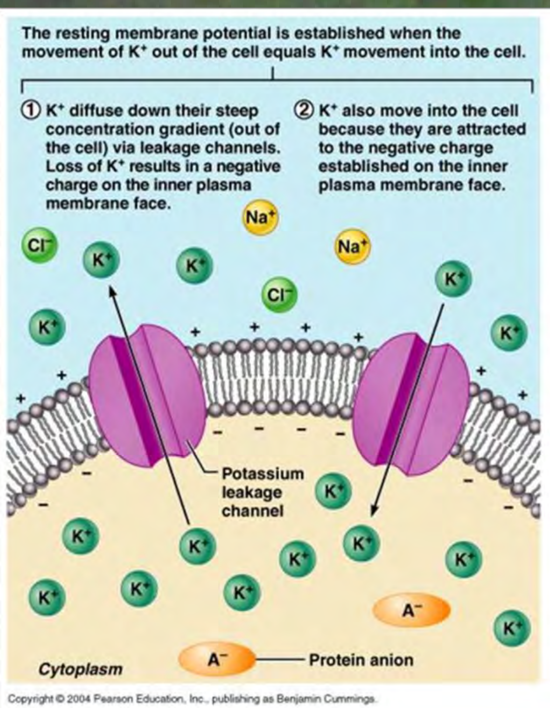


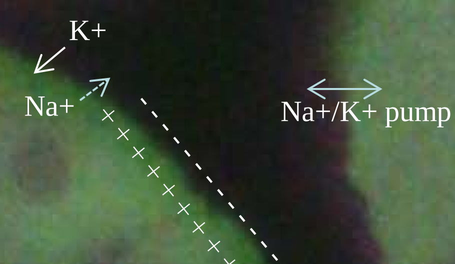
A nerve cell at rest has a high concentration of potassium ions (K+) inside the cell, and a high concentration of sodium ions (Na+) outside the cell. In any chemical system where there is a concentration difference within a solution, or between two compartments separated by a permeable membrane, substances will diffuse from the compartment of high concentration to the compartment of low concentration. In the nerve cell this results in an outflow of K+ ions and an inflow of Na+ ions.

Since the cell membrane is much more permeable to K+ than to Na+, the net flux of K+ out of cell will be much greater than the flux of Na+ into the cell. Since, however, there are many large molecules inside the cell with a surplus of negative (-) charges on them, molecules which are too large to cross the cell membrane, they will restrict the mobility of the K+ ions:



Potassium (K+) channel, protein structure
http://www.youtube.com/watch?v=UqxzSrjzJ70

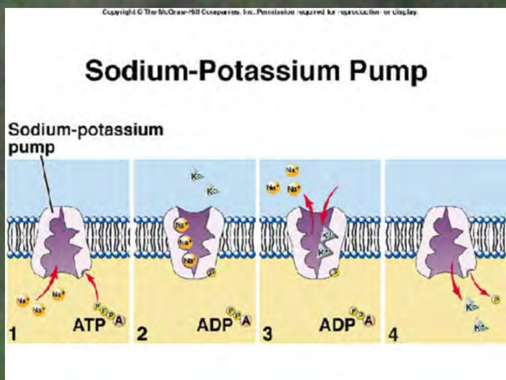




A nerve cell at rest has a high concentration of potassium ions (K+) inside the cell, and a high concentration of sodium ions (Na+) outside the cell. In any chemical system where there is a concentration difference within a solution, or between two compartments separated by a permeable membrane, substances will diffuse from the compartment of high concentration to the compartment of low concentration. In the nerve cell this results in an outflow of K+ ions and an inflow of Na+ ions.

Since the cell membrane is much more permeable to K+ than to Na+, the net flux of K+ out of cell will be much greater than the flux of Na+ into the cell. Since, however, there are many large molecules inside the cell with a surplus of negative (-) charges on them, molecules which are too large to cross the cell membrane, they will restrict the mobility of the K+ ions:

the K+ ions that leave the cell through the K+ channels will therefore ´hang` on the extracellular face of the cell membrane, dragged there because of the large negative charges on the inner side of the thin membrane. This establishes an electrical potential between inside and outside equal to -70 millivolt (mV). This is the so called resting membrane potential.

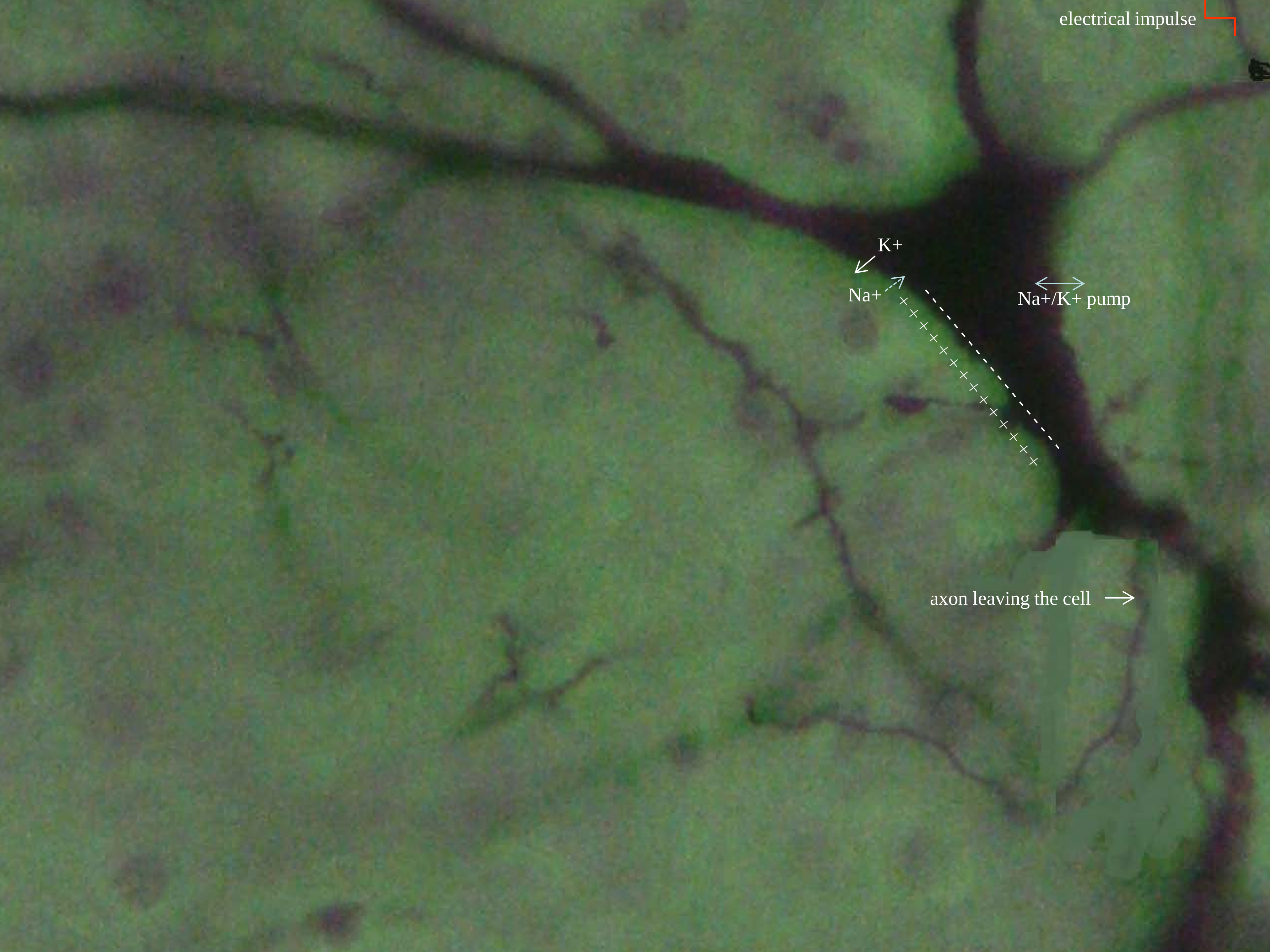


K+

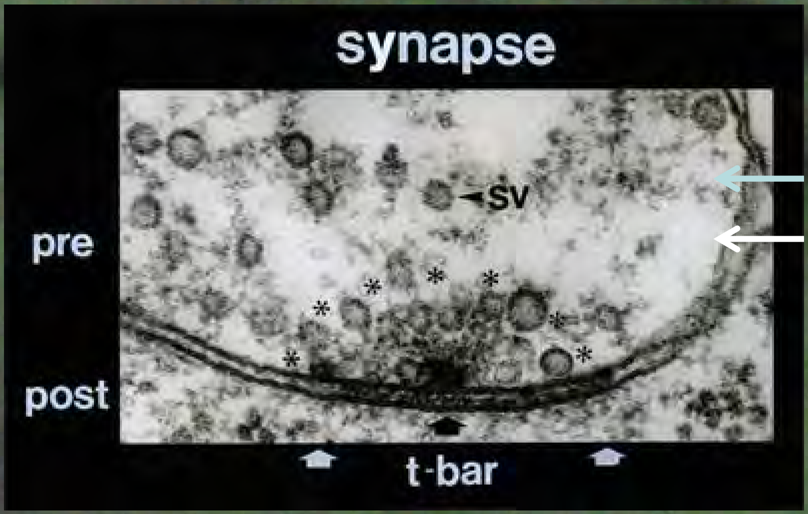
Na+

Na+/K+ pump

The diffusion of ions across the cell membrane would have resulted in a dangerous loss of K+, the concentration of which has to be constant within the cell, and also an accumulation of Na+ inside the cell, if it had not been for the so called Na+/K+ pump. This energy driven pump actively transports three Na+ ions out from the cell in exchange of two K+ into the cell to re-establish physiological steady state.

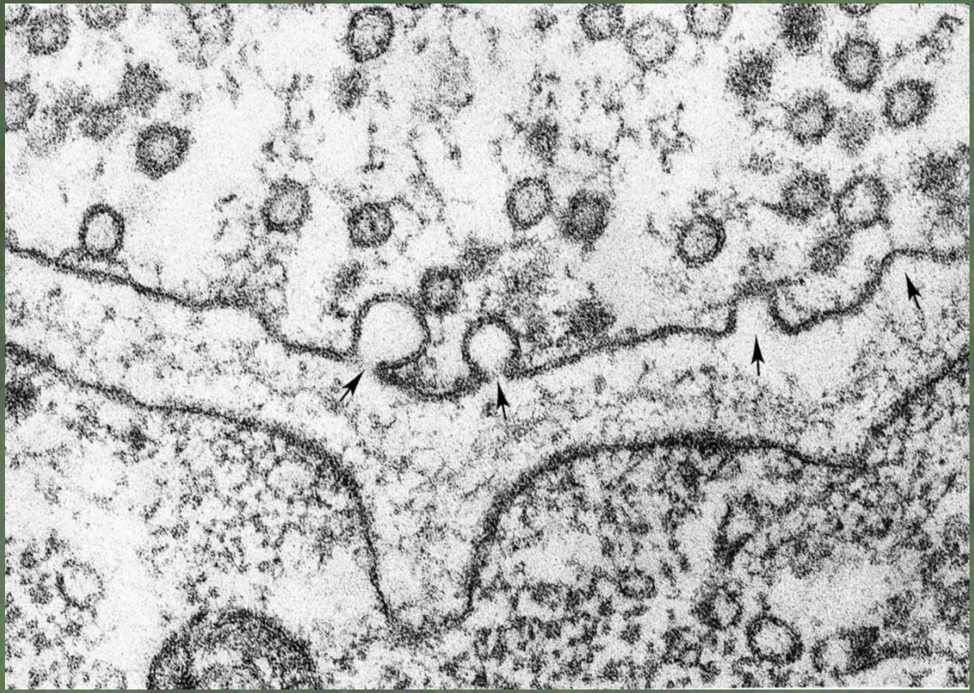

electrical impulse
K+
Na+
Na+/K+ pump
axon leaving the cell

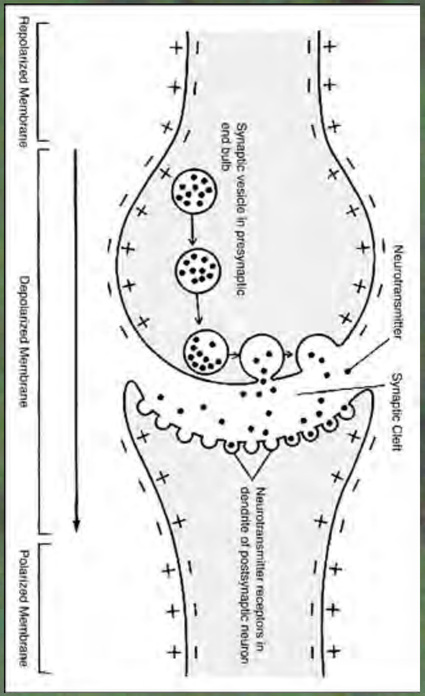
electrical impulse
Na+ →
Ca++ →



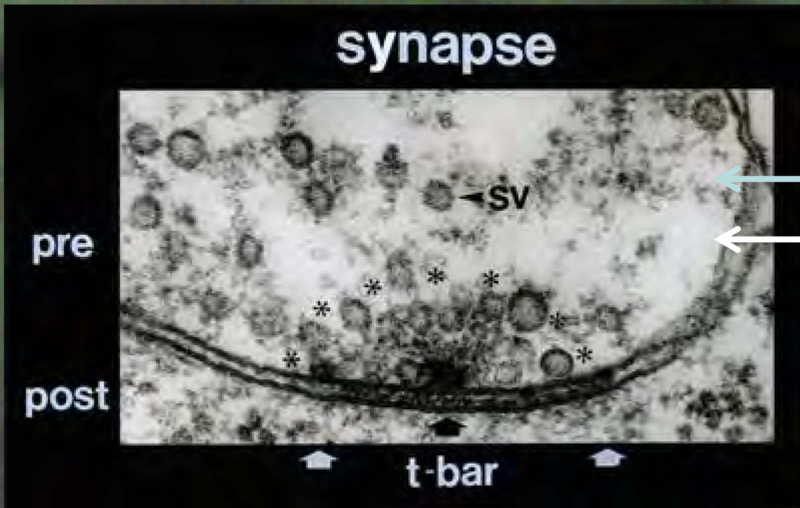
Na+ -vesicles filled with neurotransmitter molecules
empties into the synaptic cleft
Ca++ -neurotransmitter binds to receptors

K+
Na+
Na+/K+ pump





Na+ influx: depolarization



Na+

Ca++

-vesicles filled with neurotransmitter molecules
empties into the synaptic cleft

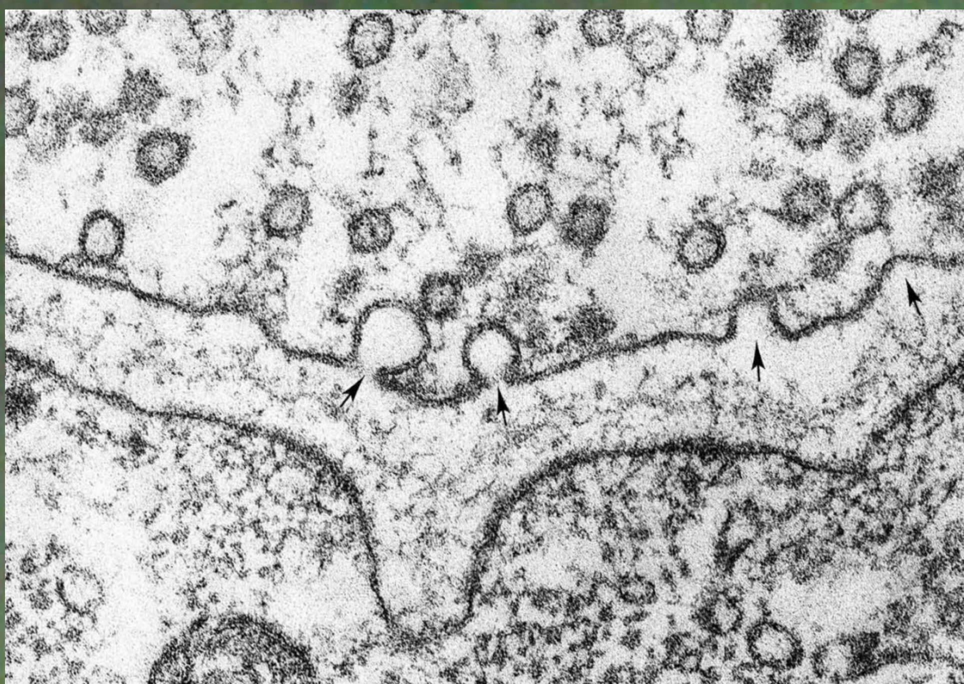
-neurotransmitter binds to receptors

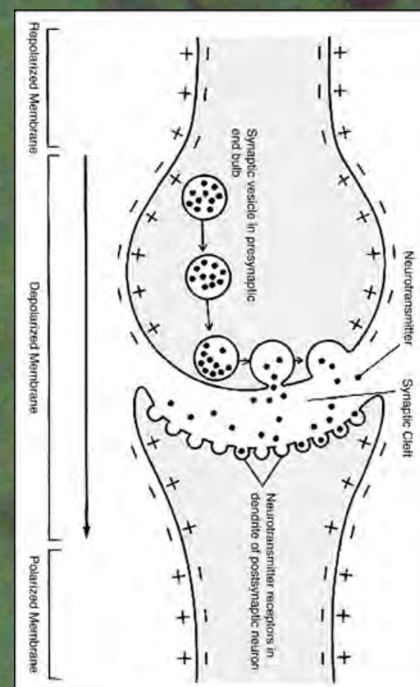
-this results in Na+ influx
and a depolarized membrane

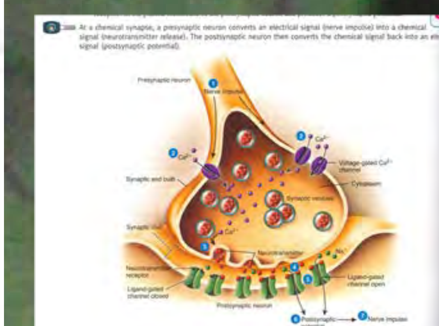
K+

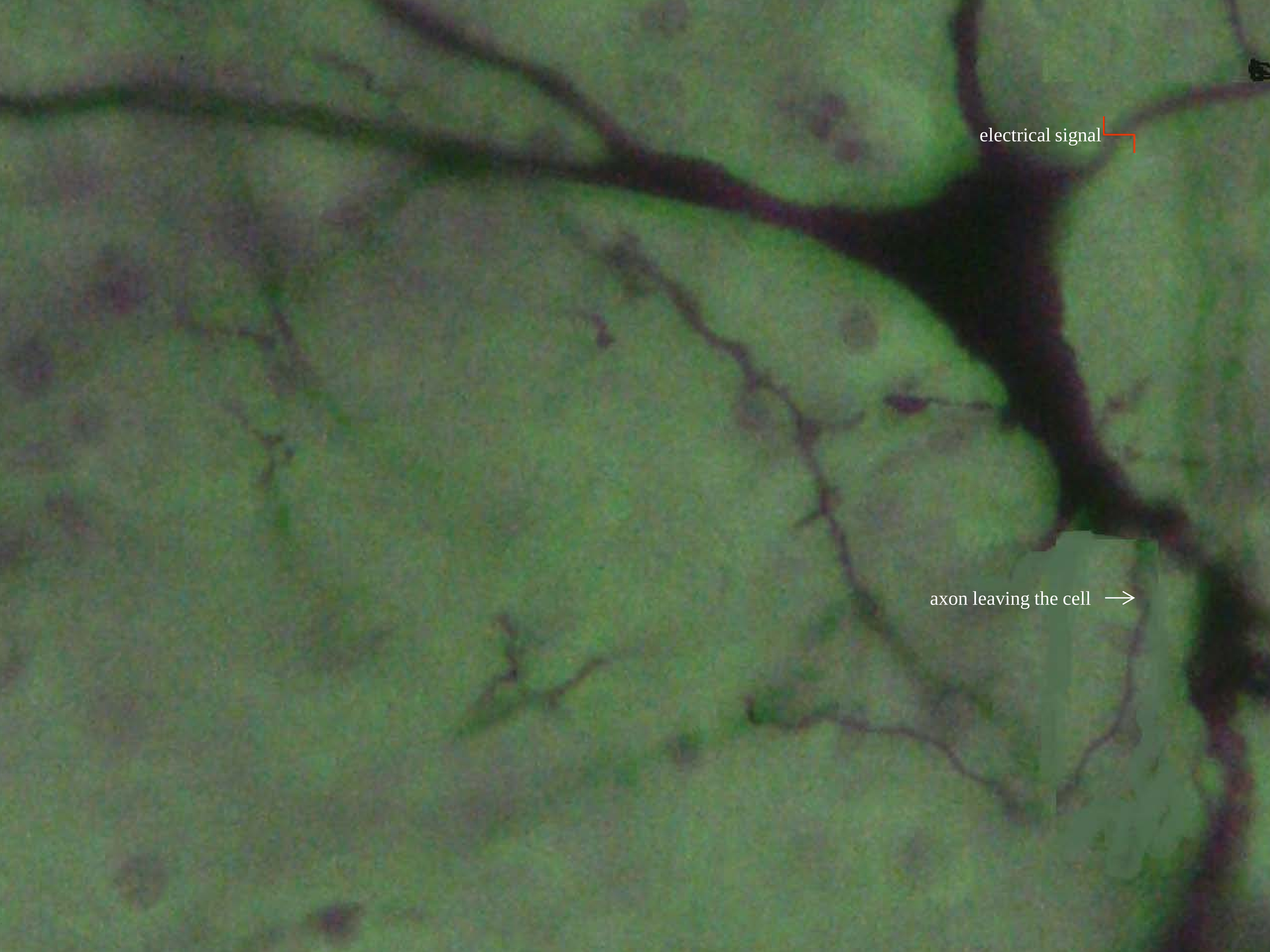
Na+

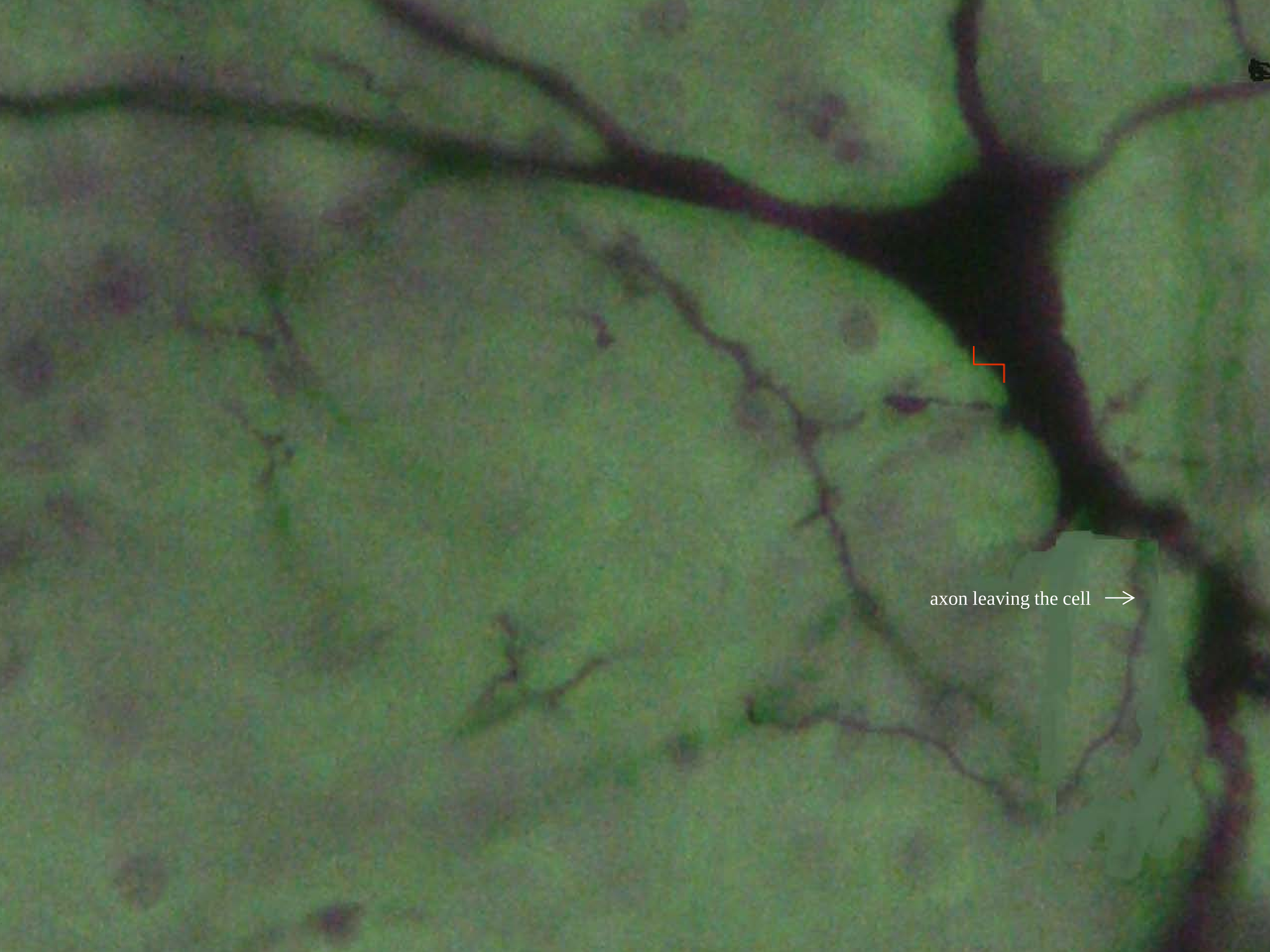
Na+/K+ pump

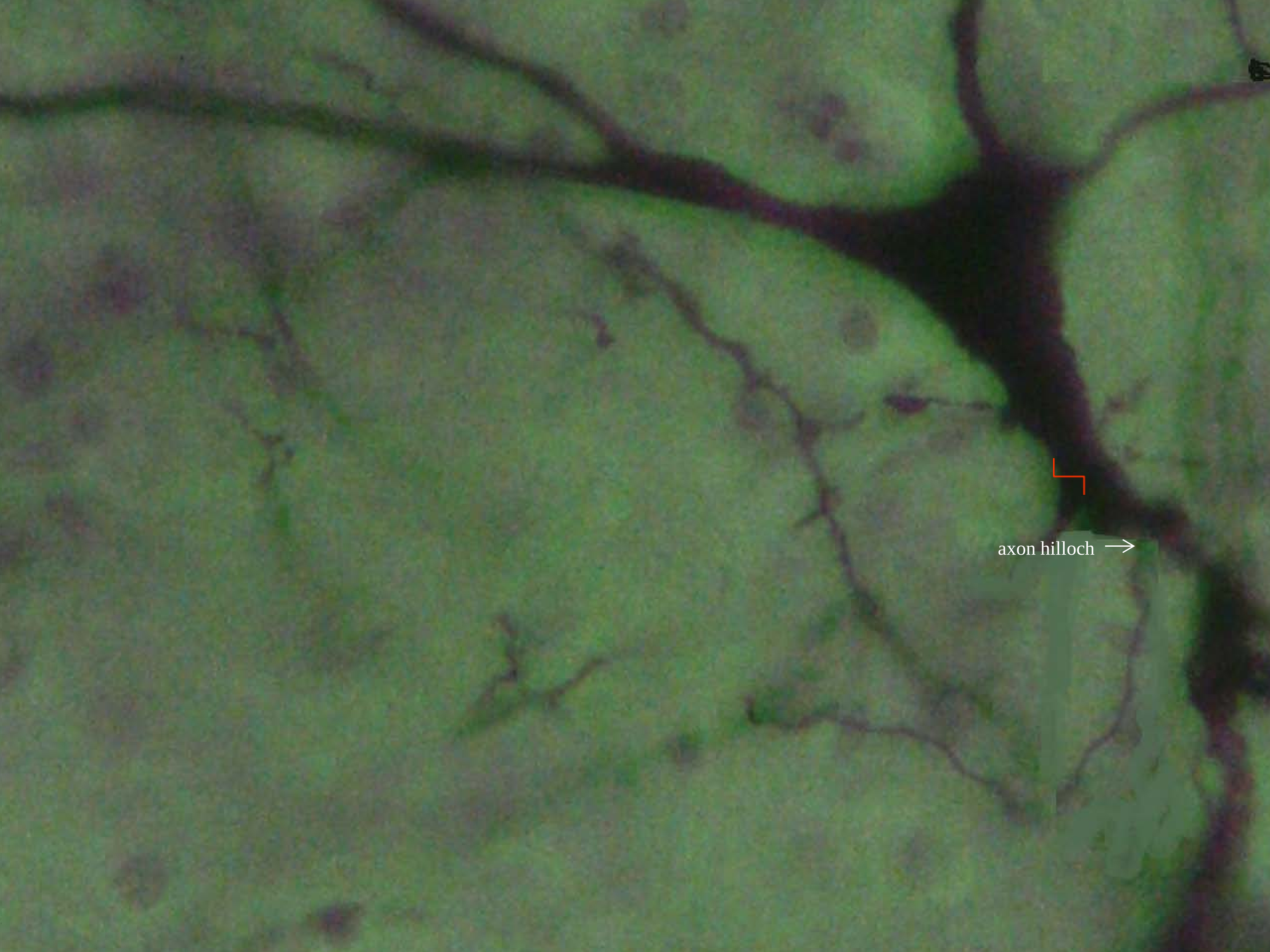


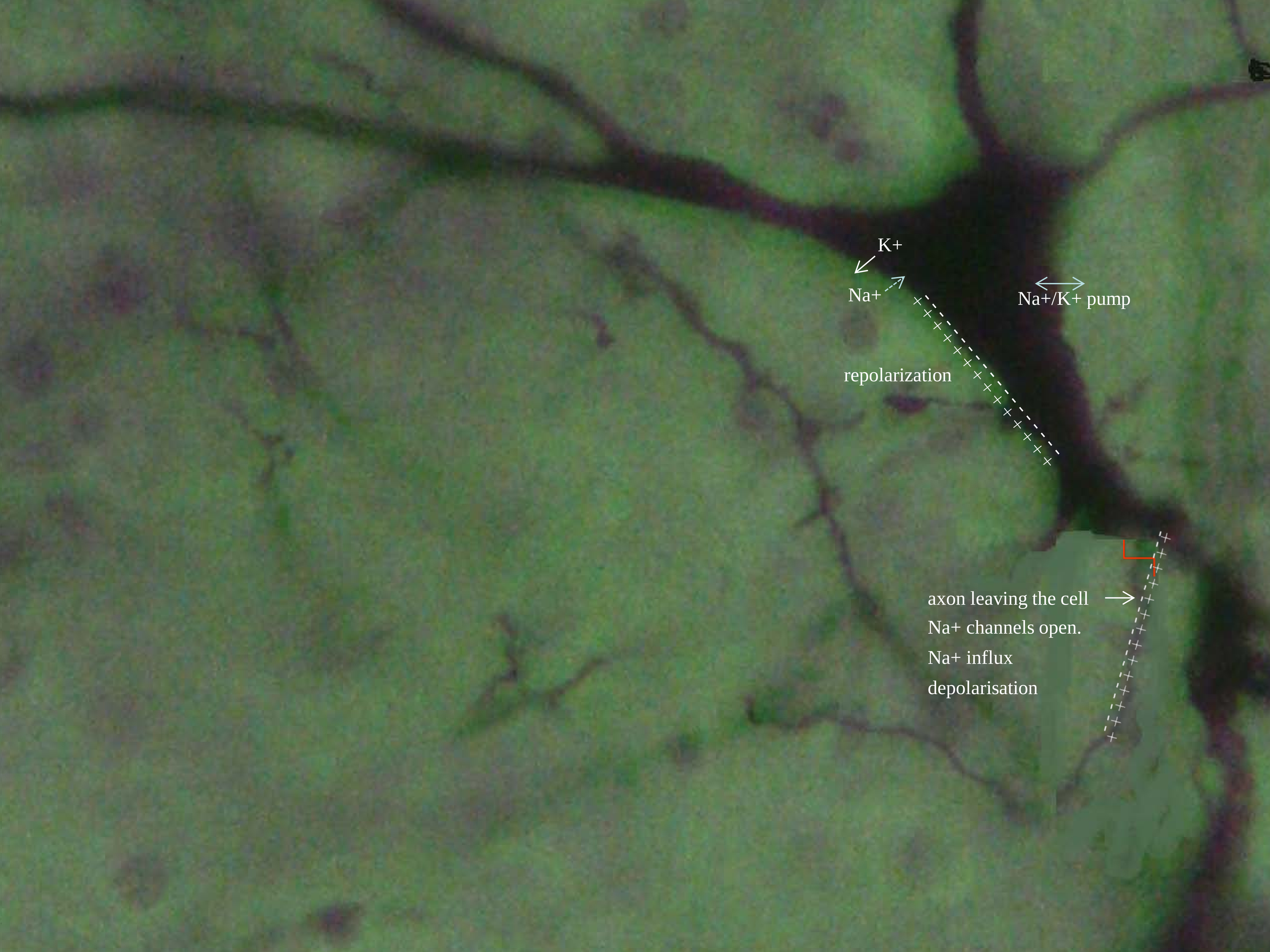


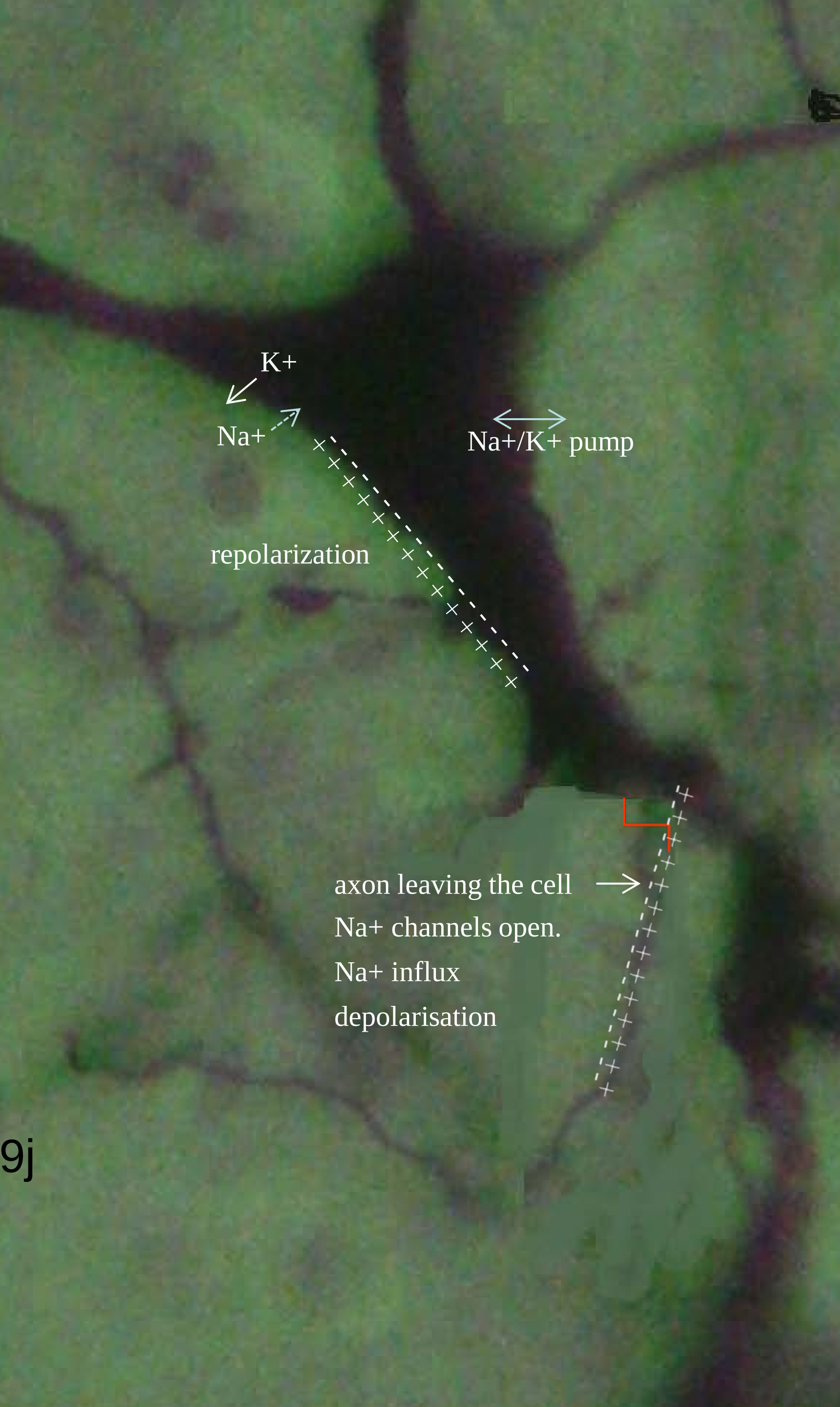


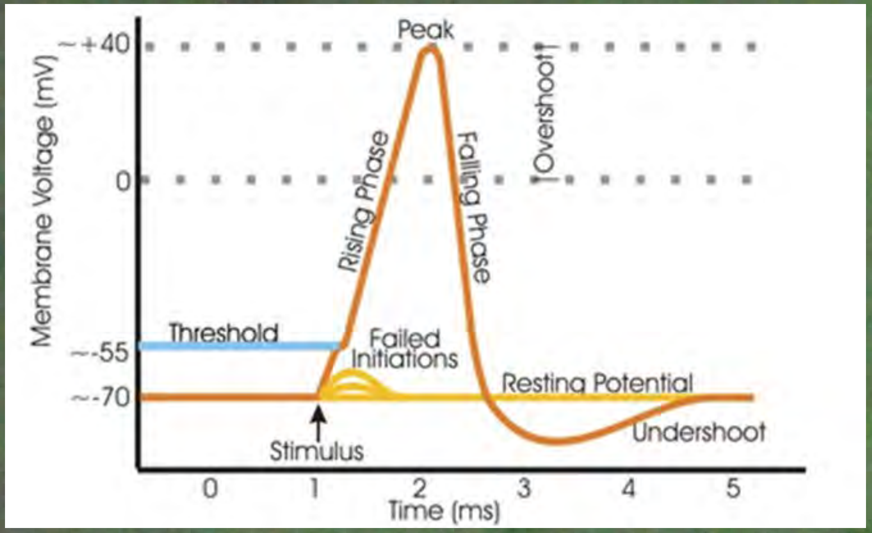

electrical signal
axon leaving the cell


axon leaving the cell

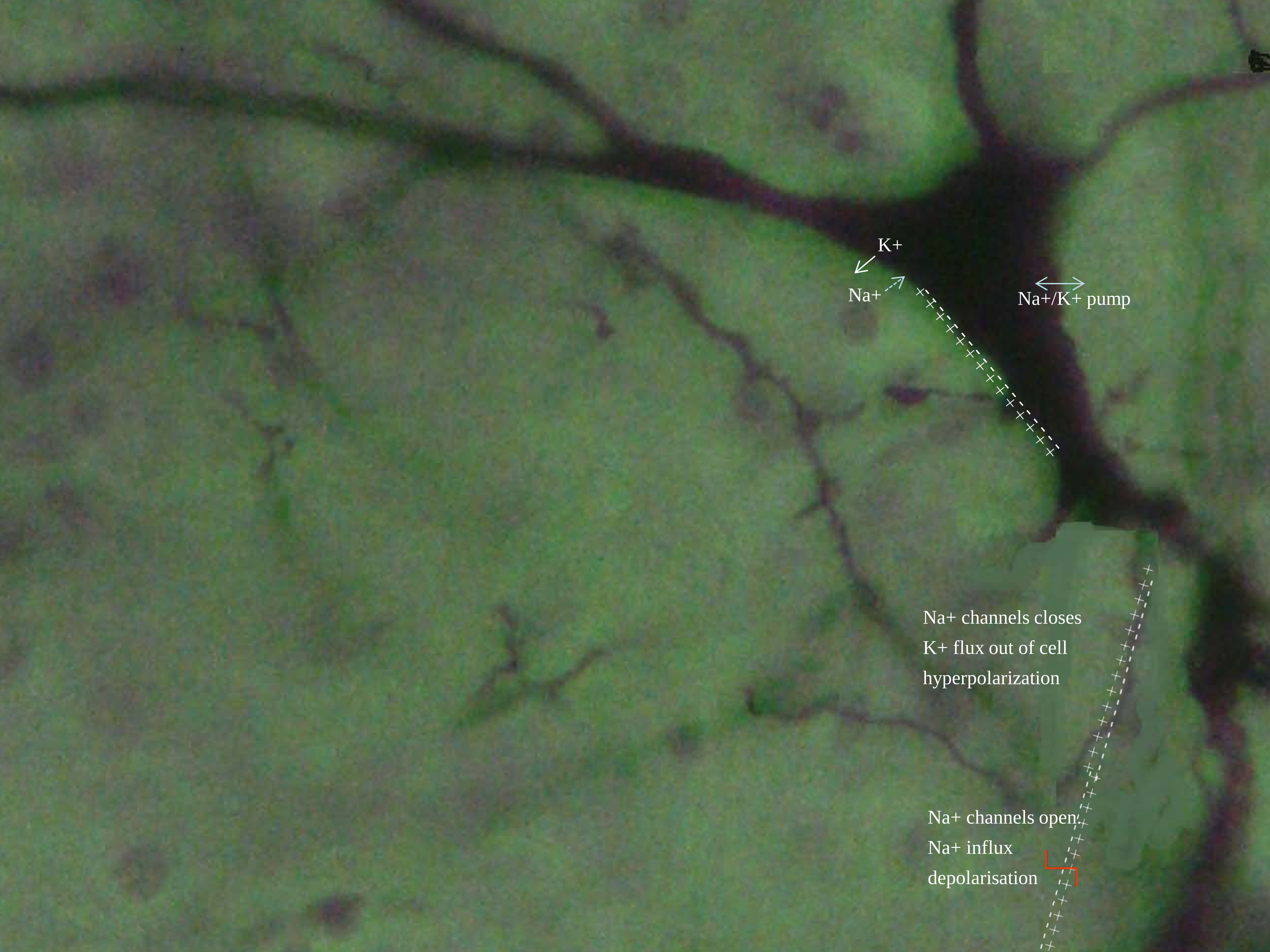

axon hilloch


K+
Na+
Na+/K+ pump
repolarization
axon leaving the cell
Na+ channels open.
Na+ influx
depolarisation





http://www.youtube.com/watch?v=LXdTg9jZYvs


K+
Na+
Na+/K+ pump
Na+ channels closes
K+ flux out of cell
hyperpolarization
Na+ channels open
Na+ influx
depolarisation